Infrastructure Asset Management Readiness Assessment of Ontario Municipal Water Utilities

by
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Author's declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

The safety and quality of services provided by municipal water utilities depend on sound water and wastewater infrastructure. Nevertheless, according to the 2016 Canadian Infrastructure Report Card, about 12% of this infrastructure is in poor or very poor condition, representing CA$51 billion in asset replacement value. Infrastructure Asset Management (IAM) is a strategic approach that encourages municipalities to take into account long-term analysis to set priorities for asset-related decisions. The Province of Ontario has developed regulations and guidelines to broadly implement municipal Asset Management Plans (AMPs). However, the existence of an AMP does not guarantee reliable IAM. For assets to be properly managed, water utilities must have processes in place to base decisions on technical and financial information, that consider assets' life cycle and levels of service. The adoption of IAM processes can be measured by a readiness assessment. The main purpose of this study is to assess the current asset management readiness level of Ontario municipal water utilities, while providing direction and support for the development of policies and guidelines. Additionally, it investigates whether AMPs are sources of information for evidence-based decision-making. The Federation of Canadian Municipalities' Asset Management Readiness Scale, the ISO 5000 series, and the Ontario Regulation 588/17 were adapted and used as a framework for a voluntary web-based survey. Data was provided by 31 municipalities representing 51% of the Ontario population. Respondents are classified into four readiness levels (RLs) – RL 1, RL 2, RL 3, and RL 4 – according to five competency areas: (1) policy and governance; (2) people and leadership; (3) data and information; (4) planning and decision-making; and (5) contribution to asset management practice. Readiness level results varied between 0.17 and 1.18 for small, medium and large municipalities, on a scale of 0 to 3. Additional results provide insights regarding levels of service, communication of key IAM information, funding gaps, service fees, and climate change aspects considered in asset management planning.

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Secondly, I am thankful to the Centre for Advancement of Trenchless Technologies (CATT) and the Ontario Water Consortium (OWC) for funding this study. Many thanks to Brenda Lucas from the OWC for her time and commitment to the project.

Equally important, I would like to acknowledge the efforts of the 31 respondent municipalities and their asset managers, who have taken time out of their busy schedules to provide invaluable data and insights on their current asset management practices.

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Finally, I would like to thank my parents for my life and my dear friends for supporting me in my dreams. A very special thanks to my long-time friend, Dr. Nathalie Kliemann, who has inspired my academic journey.

Dedication

To my beloved husband, Gustavo,

for always supporting me, no matter what,

and to my sister and best friend, Luisa,

for always believing in me.

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Chapter 1
General Introduction

1.1. Background

The safety and quality of services provided by municipal water utilities depend on sound water and wastewater infrastructure. According to the 2016 Canadian Infrastructure Report Card (CIRC), about 12% of the water and wastewater assets in Canada are in poor or very poor condition, representing CA$51 billion in asset replacement value (Federation of Canadian Municipalities, 2016). Additionally, more than two decades of underinvestment in infrastructure (1976-2000) (Ministry of Infrastructure, 2012) has resulted in depleted conditions and increased water and wastewater systems' backlog, or infrastructure that needs to be immediately replaced.

Since municipalities own over 75% of the water and wastewater infrastructure in Canada (Statistics Canada, 2018), they are responsible for funding capital investments, which are key to keeping physical assets in an adequate condition and operating efficiently. Investing in buried infrastructure is particularly challenging, due to the inherent difficulty in performing condition assessment to set priorities and support decision-making. Breaks, spills, and clogging are some of the more severe consequences of poorly managed pipelines, which force utility managers to prioritize operational costs over long-term capital investments.

Climate change is increasing the intensity and frequency of weather events, resulting in more urban flooding and other extreme events. Water utilities must adapt to this new reality to safeguard not only the integrity of physical assets but also the systems' ability to provide services. As a result, there is an urgent need to strengthen water infrastructure resilience in the face of climate change impacts. This is further aggravated by the worldwide tendency of high-density urban living and the consequent difficulty of interfering with existent buried infrastructure.

Infrastructure Asset Management (IAM) is a strategic approach that encourages municipalities to take into account long-term analysis to set priorities for asset-related decisions. This framework considers a life-cycle perspective to establish assets' characteristics, replacement value, current condition, and operational performance, to subsequently define the costs and

timeframe for asset maintenance, renewal or replacement, while providing the desired level of service.

In parallel, PS 3150 is the Federal Regulation that provoked a seminal change in Canada: from 2009 on, municipalities' financial statements must include tangible capital assets, thus shifting the perception towards infrastructure from cost to asset (Public Sector Accounting Board, 2007). Later, in 2014, the Province of Ontario linked the approval for the Federal Gas Tax Fund to the development and implementation of Asset Management Plans (AMPs) for core infrastructure assets (Ministry of Infrastructure, Communities and Intergovernmental Affairs of Canada, 2014). As a result, all municipalities in Ontario currently have an Asset Management Plan (Scantlebury, 2019). More recently, the Province of Ontario has developed the Ontario Regulation 588/17, tackling Asset Management Policy, climate change and levels of service.

1.2. Problem Statement and Motivation

Canadian municipalities understand how asset management can positively impact organizations and are strongly embracing this framework. However, the existence of a municipal Asset Management Plan does not guarantee reliable infrastructure asset management practice. For assets to be properly managed, water utilities must have processes in place to base decisions on technical and financial information, that considers assets' life cycle and levels of service. As a consequence, gauging municipalities asset management adoption entails understanding their asset management processes.

Furthermore, municipal water utilities' approaches to asset management might diverge due to population size, system configuration (dispersed versus concentrated), geography, network profile (material, age, diameter, etc.) and business strategy. With asset management being a growing priority in Canada and particularly in Ontario, several communities of practice have developed readiness or maturity assessment tools as an attempt to determine organizations' asset management levels of practice. Nonetheless, these tools often require the engagement of a team of professionals answering usually more than 100 detailed questions, which can be extremely time and cost intensive.

Additionally, even when municipalities choose to perform a readiness assessment, the results typically stay in the organization and are not shared with the industry. Consequently, there is a limited number of studies available concerning municipalities' asset management practices to inform policy, develop guidelines and serve as a benchmark for municipal water utilities (Federation of Canadian Municipalities, 2016; Federation of Canadian Municipalities, 2019; Ontario Sewer & Watermain Construction Association, 2018; Public Sector Digest, 2018; Statistics Canada, 2018). These studies are mainly developed by communities of practice to fill a specific gap, being either very broad and not focusing specifically on water utilities or being geared towards answering a particular question.

Regardless, new asset management regulations and guidelines are frequently being released in Canada and especially in Ontario, with limited information on how municipalities are actually implementing the asset management framework. One example is the ON Reg. 588/17, that required municipalities to prepare an Asset Management Policy by July 2019 and define current and proposed levels of service by 2021 and 2024 respectively (Ministry of Infrastructure, 2017).

1.3. Research Objectives

The primary goal of this research is to inform asset management policies, regulations and guidelines by identifying the asset management practices currently employed by Ontario municipal water utilities. To help closing this information gap, the specific objectives of this research are as follows:

(a) Create a simple web-based methodology for assessing asset management readiness levels
(b) Determine the asset management readiness level of Ontario municipal water utilities
(c) Examine how municipality size shapes the adoption of the asset management framework
(d) Investigate whether Asset Management Plans are used as sources of information for evidence-based decision-making
(e) Use the results of the identified practices to inform policy and guidelines in Canada and internationally by publishing an industry report.

1.4. Thesis Organization

This thesis follows a conventional arrangement and is organized in six chapters and four Appendices. Chapter 2 provides an overview of the state of infrastructure in Canada, the main asset management challenges faced by municipal water utilities and the current legislative requirements. It also analyses four of the most relevant asset management frameworks and three publicly available readiness assessment tools, along with previous asset management practices studies.

The methodology for the Water and Wastewater Asset Management Readiness Assessment survey is discussed in detail in Chapter 3. Chapter 4 brings the main survey results divided by competency area and municipality size. Additional results concerning the consideration of climate change in asset management planning, the identification of funding gaps and the asset management benefits are also presented.

The analysis of the findings and comparison against other relevant studies is developed in Chapter 5. Finally, Chapter 6 offers a summary of the study findings and recommendations for future work.

Appendix A contains the survey's questionnaire, while Appendix B shows the introductory text to the survey. Next, Appendix C depicts a model for the benchmark report and Appendix D provides relevant results tables.

Chapter 2
Literature Review

2.1. Overview

The purpose of this literature review is to provide the necessary context and knowledge for the development of a methodology to asses asset management practices in municipal water utilities. First, the data on the current state of water and wastewater infrastructure in Canada and Ontario is examined in Section 2.2, to evidence the size of the infrastructure deficit. Then, the main challenges faced by water utilities in managing their assets are explored in Section 2.3. Section 2.4 discusses the asset management legislative requirements in Ontario, and how they have stimulated municipalities to develop their AMPs.

An overview of ISO 55000 series and other three widely known asset management frameworks is given in Section 2.5. This was a vital step towards understanding the Asset Management System structure. Section 2.6 analyses three publicly available readiness assessment tools, aiming to set out asset management outcomes and best practices. Finally, a review of relevant asset management studies is conducted in Section 2.7, and a brief summary of the main conclusions of this literature review is outlined in Section 2.8.

2.2. State of Water and Wastewater Infrastructure in Canada and Ontario

Water and wastewater infrastructure are vital for urban living and, as a result, are classified as “core infrastructure”. Canada owns approximately 185,000 Km of water pipes and 150,000 Km of sewer pipes, which have mostly been built during the past century. Additionally, the country has, as of 2016, more than 2,000 water treatment facilities and 3,000 water pump stations, and also close to 1,300 wastewater treatment plants and 11,000 wastewater pump and lift stations (Statistics Canada, 2018).

Keeping tabs on the state of infrastructure is key to plan system interventions and funding. Several organizations have given this matter considerable attention by publishing “State of

Infrastructure Reports" (SOIR), and in Ontario, SOIRs are a required section of the AMP. Asset age, physical condition ranking, replacement value and annual reinvestment rate are the most common parameters to gauge infrastructure health. Unsurprisingly, there has been underinvestment in linear assets and the water and wastewater backlog continues to increase.

In 2007 *Mirza* published a seminal study for the Federation of Canadian Municipalities (FCM) entitled "Danger ahead: the coming collapse of Canada's municipal infrastructure". At that time, he estimated a CA$ 31 billion deficit for water and wastewater infrastructure in Canada, reflecting the financial needs for maintaining or upgrading existent municipal assets. New infrastructure needs were estimated at CA$ 56.6 billion (Mirza, 2007). The indisputable conclusion had been the acceleration of infrastructure backlog, with a recommendation to set a national plan to better manage infrastructure in the future.

In contrast, the Canadian Infrastructure Report Card (CIRC) is an endeavor of four organizations, including FCM, to assess infrastructure health across the country. The 2012 and 2016 reports were based on surveys, while the 2019 report was much shorter and used the 2016 data available from Statistics Canada - Canada's Core Public Infrastructure (CCPI) survey. The 2016 CIRC report extrapolated the results of the 120 surveyed municipalities to a national context to find that 12% of the water infrastructure is in poor or very poor condition, representing CA$25 billion in replacement value. Similarly, 11% of the wastewater assets are in poor or very poor condition, indicating a CA$26 billion backlog (Federation of Canadian Municipalities, 2016).

The 2019 CIRC presents the following assessment for assets in poor and very poor condition: 9.6% of linear water assets, 6.4% of non-linear water assets, 10.8% of linear wastewater assets, and 10% of non-linear wastewater assets. Still, it is important to consider that 15% of the linear wastewater assets and 6% of the linear water assets have unknown condition, which could greatly impact the estimates for deteriorated condition (Federation of Canadian Municipalities, 2019). Unfortunately, the 2019 CIRC does not provide replacement value data.

Annual reinvestment rates give an indication of asset expected useful life and potential backlog growth. According to the 2016 CIRC, the reinvestment rate for water linear assets is 0.9% per year (Federation of Canadian Municipalities, 2016). This indicates that it would take on average 111 years for a municipality to replace its entire water network. Considering that water pipes have an expected life of 50 to 100 years, the ideal annual reinvestment rate ranges from 1.0%

to 1.5% per year. Anything below this rate would contribute to increase the water infrastructure backlog and the deteriorated condition of water pipes.

This aligns with findings from *Folkman* and *Baird*, stating a reinvestment or replacement rate of 0.8% per year for linear water assets in Canada and US (Baird & Folkman, 2019). They have also reported a 27% increase in watermain break rates in the past six years, with small utilities having two times more watermain brakes than large ones (Folkman, 2018). Equally important, the 2016 CIRC provides a disappointing replacement rate of 0.7% per year for sewer pipes, when the recommended rate is 1.0% to 1.3% per year (Federation of Canadian Municipalities, 2016). It is important to note that the current replacement rates are contributing to further increase the infrastructure backlog, and that rates in the past decades might have been even lower (Mirza & Ali, 2017).

Alternatively, SOIRs in Ontario have focused on a limited sample of municipalities and have not provided extrapolated replacement values. Nevertheless, they offer a good indication of the Province's water and wastewater infrastructure health. The Ontario Sewer & Watermain Construction Association (OSWCA) surveyed 30 municipalities representing 30% of Ontario's population. The study concluded that 20% of water, wastewater and stormwater linear infrastructure, valued in CA$ 8 billion, is in poor or very poor condition (Ontario Sewer & Watermain Construction Association, 2018).

The Public Sector Digest (PSD) is a consulting firm based in Ontario that specializes in asset management for municipalities. The Association of Municipalities Ontario (AMO) requested PSD to develop "The State of Ontario's Infrastructure" report, so it could evaluate the impact of the Federal Gas Tax Fund requirements. PSD used a sample of 35 municipalities, retrieving data from their 2013 and 2016 AMPs. Part II of the report shows an annual deficit for the 35 municipalities water and wastewater assets close to CA$ 18.5 million in 2016. It also indicated an increase in the assets' backlog of 30% when compared to 2013 data, representing close to CA$ 770 million in replacement value (Public Sector Digest, 2018).

As demonstrated, water and wastewater infrastructure are in dire need of attention and investments, if we are to sustain the quality of life in Canada. This requires an understanding of the specific challenges these assets impose, especially regarding buried infrastructure.

2.3. Challenges of Infrastructure Asset Management for Municipal Water Utilities

Water utilities have a particularly challenging combination of factors that influence the way infrastructure is managed. The existent backlog of water and sewer pipes, the difficulty in assessing the condition of buried infrastructure, and the remuneration through user fees that usually does not incorporate the full costs of providing water and wastewater services are the main contributing aspects to water infrastructure asset management (Mirza & Ali, 2017; Mazumder, Salman, Li, & Yu, 2018).

Despite the fact that water and sewer pipes have long service lives, typically between 50 and 100 years, maintenance and timely renewal are required to support service delivery. When these interventions are deferred, asset condition is allowed to deteriorate, which in turn generates more expensive maintenance or asset renewal ahead (Mirza & Ali, 2017). Poor and very poor physical conditions increase the already large backlog of buried infrastructure, contributing to a vicious circle where costs for maintenance, renewal and eventually, replacement, increase with depleted asset condition.

Furthermore, accurate data on the condition of linear assets provides crucial information to plan for funding of capital expenditures. Assessing the state of buried infrastructure through physical inspection tends to be difficult and costly. For sewers, closed circuit television (CCTV) is commonly used, which involves recording the pipe interior with a moving device and having those images analyzed by a specialist. As expected, condition assessment is vastly more complicated for watermains, given that potable water pipes work under pressure, have small diameters, need bypasses to guarantee continuous water supply, and require disinfection of the pipe and the inspection equipment. As a consequence, indirect methods are typically used for water systems (Mazumder, Salman, Li, & Yu, 2018). Nevertheless, due to the high costs of water and wastewater pipes' physical inspections, their condition is frequently inferred through age, a less than optimal and often misleading approach (Public Sector Digest, 2018).

Once linear assets renewal and replacement capital investments cannot be accurately determined due to condition assessment deficiencies, utilities find themselves prioritizing short-term needs. In addition, user fees generally do not account for the full cost of services, which is unbalanced with municipal infrastructure responsibilities. For small utilities the scenario is even more serious, given they have a smaller user base to pay for investments. The consequence is the

deferral of capital expenditure, increasing the infrastructure backlog. If we ought to have asset intergenerational affordability, flexible financing mechanisms and permanent funding sources should be made available for capital expenditures, and full cost recovery fees must be practiced for operational expenditures (Mirza & Ali, 2017).

All in all, we still have to account for the effects of climate change, rapid urbanization and of a service-centric approach. Balancing the trade-offs of performance, cost and risk is something citizens must be aware of. A holistic approach is required to deal with the challenges of managing municipal water assets, one that includes implementing best practices and supporting regulation (Jones, 2014).

2.4. Infrastructure Asset Management Legislative Requirements

The gradual implementation of asset management regulation in Ontario has pushed the subject into municipal water utilities agenda and greatly contributed to give the matter a high-priority status. One example of this is that in 2016 almost 96% of municipalities in Ontario had an Asset Management Plan, while the Canadian average was close to 39% (Statistics Canada, 2018). Such high numbers in Ontario have been possible as a result of a progressive and robust set of legislative requirements.

In 2007, the Public Sector Accounting Board (PSAB) established national standards on how to account for and report tangible capital assets, through PS 3150. Effective in 2009, municipalities were required to report assets as tangible capital assets on audited Financial Statements, as opposed to reporting them as expenses (Public Sector Accounting Board, 2007). As a result, municipalities had to develop a full inventory of assets, often the first step to good asset management practices.

The Government of Ontario introduced in 2010 the Water Opportunities Act. One of the purposes of this legislation was to encourage water conservation and sustainability in the short and long-term. For that reason, municipal service providers should submit to the Ministry of Environment a Municipal Water Sustainability Plan, which might include an Asset Management Plan for the physical infrastructure (Government of Ontario, 2010). This was the first time AMPs

were required from municipalities, although there was no guidance on how to develop these plans at that time.

Two years later, in 2012, the Ministry of Infrastructure released "*Building Together – Guide for Municipal Asset Management Plans*". This guide represented a move towards Plans' standardization and consistency. Furthermore, it presented the discipline of asset management as the foundation of the strategy to deal with municipal infrastructure financial challenges. Important concepts, as the fact that timely renewal investments throughout assets' life cycle could be more cost effective than running the assets to failure and then replace them, were introduced (Ministry of Infrastructure, 2012). Part three of the guide detailed the elements of an AMP, specifically: a) executive summary; b) introduction; c) state of local infrastructure; d) expected levels of service; e) asset management strategy; and f) financing strategy. However, the critical shift was that the Province indicated that municipalities seeking provincial capital funding had to prepare detailed AMPs, pointing out that Plan development would soon be a requirement for funding.

The Federal Gas Tax Fund (GTF) is a consistent source of funding for municipal infrastructure. The Association of Municipalities Ontario (AMO) helps distributing over CA$ 800 million per year to municipalities, based on a per-capita allocation (Association of Municipalities Ontario, 2018). The 2014 *Administrative Agreement on the Federal Gas Tax Fund* requested municipalities to develop and implement an AMP according to the requirements set out in Ontario's Building Together guide by December 31, 2016 (Ministry of Infrastructure, Communities and Intergovernmental Affairs of Canada, 2014). Starting in 2017, AMPs were an official requirement for Ontario municipalities.

The purpose of the 2015 *Infrastructure for Jobs and Prosperity Act*, also known as "*Bill 6*", was to encourage structured and evidence-based infrastructure planning (Government of Ontario, 2015). Equally important, it has given authority to the Province to regulate municipal asset management planning, which has been done through the *Ontario Regulation 588/17*. This regulation mandates municipalities to develop a Strategic Asset Management Policy and greatly expands on AMPs prerequisites. Requirements are phased, as depicted in Figure 2.1.

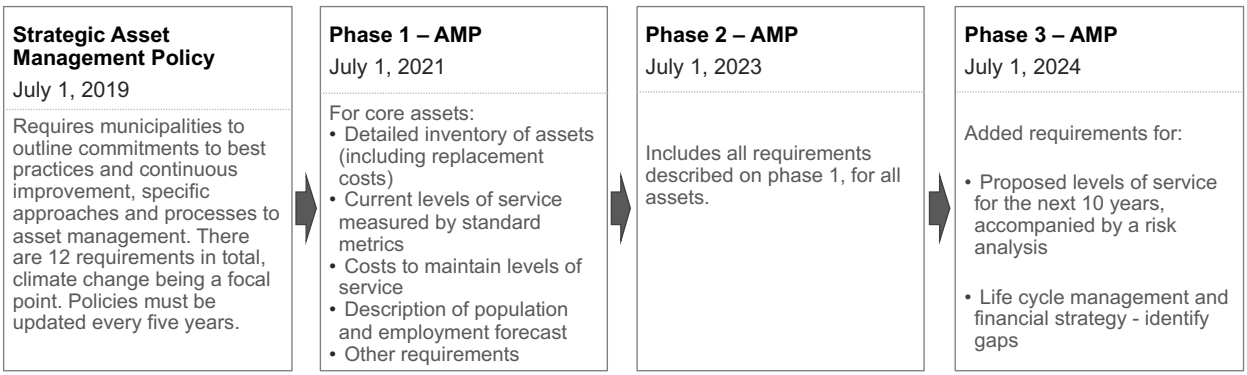

Figure 2.1: Requirements and deadlines of ON Reg. 588/17.

The Strategic Asset Management Policy required by the Government of Ontario is a compilation of an Asset Management Policy with an Asset Management Strategic Plan, as specified by worldwide known asset management frameworks, such as the ISO 55000 series and the Asset Management Anatomy. Principles, commitments, approaches and processes applied to manage municipal assets outline the 12 requirements that shall be included in the Strategic Asset Management Policy. The most relevant commitment would be to consider climate change mitigation, adaptation and anticipated costs in asset management planning (Ministry of Infrastructure, 2017).

Phases 1 and 2, as described in Figure 2.1, bring new AMPs requirements focusing particularly on Levels of Service (LoS). Tables with qualitative descriptions and technical metrics are provided for the core assets – water, wastewater, stormwater, bridges and municipal roads. Phase 3 brings additional requirements for AMPs, that must be accomplished by July 2024. Information on proposed LoS for the next 10 years must be determined for each asset category, in addition to the lifecycle management and financial strategy descriptions (Ministry of Infrastructure, 2017).

Ontario Regulation 588/17 also states that AMPs, developed from July 2021 onward, must be endorsed by municipality's executive lead and approved by a resolution passed by the municipal council. Plan implementation progress is to be assessed in an annual review conducted by the municipal council from July 2024 onwards (Ministry of Infrastructure, 2017). This is an important

step to hold top management and the municipal council accountable and committed to AMP development and implementation.

Legislative requirements have been an important driver in advancing asset management practices in Ontario, especially when compared to the regulations in other provinces or even in the USA. Only recently the *America's Water Infrastructure Act* (AWIA) of 2018 was established, urging states to encourage the development and implementation of municipal AMPs (Committee of Environment and Public Works, 2019). Nevertheless, AMPs' implementation relies on a structured asset management system, with processes designed to guarantee that the best possible decision regarding assets is being taken. In this context, asset management frameworks set the basic elements to a comprehensive system's approach.

2.5. Infrastructure Asset Management Frameworks

Asset management frameworks represent organizations or communities of practice's understanding of the principles, ideas and information that are essential to the asset management discipline. By providing these essential elements, frameworks help set up the backbone of the Asset Management System.

This section reviews the most prominent and largely known asset management frameworks. The objective here is to identify the best practices and recommended requirements to the AMS. For this purpose, the ISO 55000 series, the IAM's Anatomy, the GFMAM's Landscape, and the NAMS & IPWEA's International Infrastructure Management Manual are examined.

2.5.1. ISO 55000 Series

The ISO 55000 series was originally published in 2014 and encompasses three asset management standards that can be applied to all types of assets and organizations:

- ISO 55000: Overview, principles and terminology;
- ISO 55001: Management systems — Requirements; and
- ISO 55002: Management systems — Guidelines for the application of ISO 55001.

This series build up on the PAS 55 standard, published by the British Standards Institution (BSI) and the Institute of Asset Management (IAM). PAS 55 was envisioned to formally document good industry asset management practices. The last version of this document was published in 2008, but after the release of ISO 55000:2014 series, both organizations recommended the transition to this most current standard (British Standards Institution UK, 2014).

ISO 55000 provides an overarching and internationally agreed vocabulary by defining key asset management terms. Assets, for example, are defined as "*item, thing or entity that has potential or actual value to an organization*", while asset management is the "*coordinated activity of an organization to realise value from assets*". Value, on its turn, is determined by the organization and its stakeholders in alignment with the organizational objectives, and can be financial or non-financial, tangible or intangible. Therefore, asset management must consider the value the asset brings to the organization (International Organization for Standardization, 2014).

Another crucial concept is that an asset's life cycle starts with the identification of the need of the asset, all the way through its disposal, including any incurred liabilities (International Organization for Standardization, 2014). According to ISO 55000, a risk approach must be adopted while making asset-related decisions throughout the asset's life cycle.

Ultimately, asset management is a trade-off of cost (social, environmental and financial), risk and performance, where low risk, low cost and high asset performance are extremely rare. Balancing these aspects while supporting value realisation tends to be extremely beneficial to asset-intensive organizations. Some of the organizational benefits of asset management mentioned in ISO 55000 include demonstrated compliance, improved services and outputs, better management of risk, improved financial performance, and informed asset investment decisions.

The Asset Management System is defined as the "*set of interrelated or interacting elements to establish asset management policy, asset management objectives and processes to achieve those objectives*". The requirements for the AMS are specified in ISO 55001, which presents 27 requirement clauses as depicted in Figure 2.2.

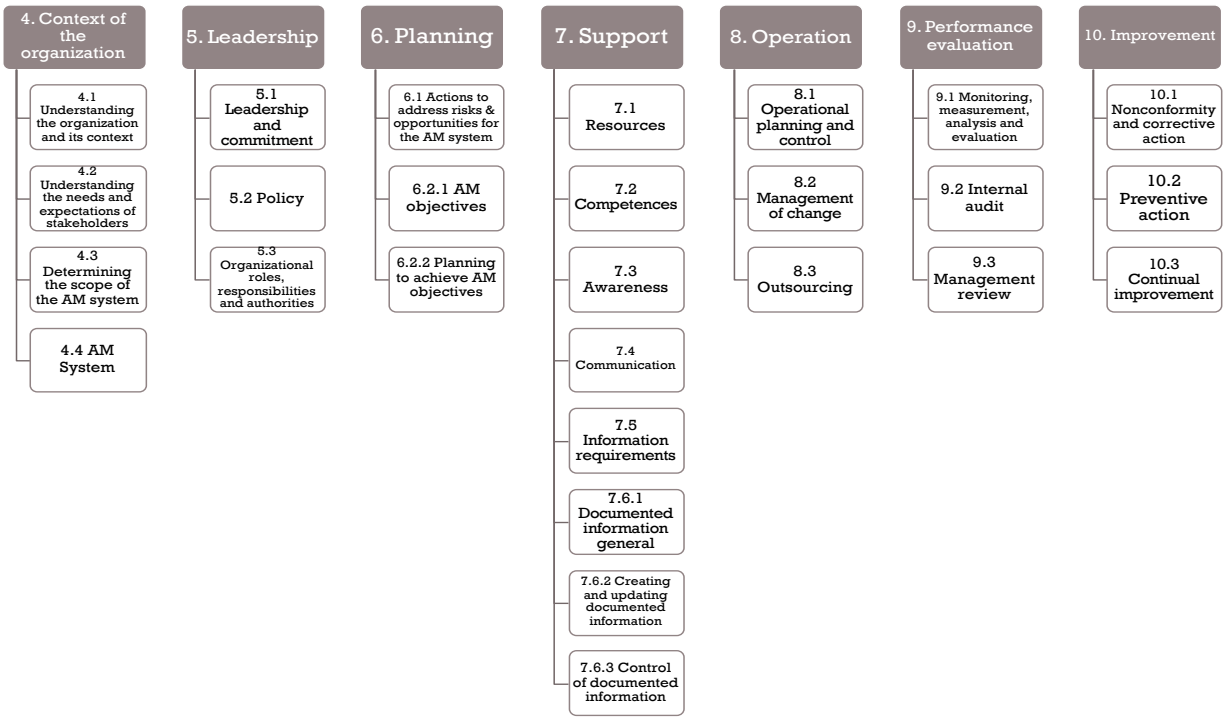

Figure 2.2: Asset Management System requirement clauses, as specified by ISO 55001.

These requirement clauses provide a holistic and integrated framework to the AMS. Item "4" considers the organizational context in addition to the stakeholders' needs and expectations to determine the AMS scope and structure. Leadership and commitment, specially by top management when setting principles and approving the Asset Management Policy, support the definition of roles and responsibilities in the asset management team, according to Item "5". The planning clauses, showed in Item "6", address a risk approach to set asset management objectives and the planned actions to achieve those objectives (International Organization for Standardization, 2014).

All these processes need to be supported by appropriate resource allocation, diligent staff competence management and awareness, proper internal and external communication of relevant information, and adequate documentation management, as described in Item "7" clauses. Item "8", operation, involves operational planning and control, in addition to change management and the definition and management of outsourced activities. Performance evaluation of assets and the AMS comprises setting monitoring, measurement, analysis and evaluation processes, as well as an internal audit of the System, in addition to System's planned and recurrent review by top

management, according to Item "9". Finally, Item "10" establishes a context of continual improvement to assets, asset management and the AMS by addressing nonconformities and potential events, respectively through corrective and preventive actions (International Organization for Standardization, 2014).

ISO 55002 offers guidance on the design and operation of the AMS, in accordance with the requirements of ISO 55001. A new version of ISO 55002 was published in 2018, claiming to be based on the experience of organizations around the world that have successfully implemented ISO 55001. For the purpose of this literature review, ISO 55002:2014 is considered.

ISO 55002 brings a pivotal concept to the AMS, precisely the concurrent alignment of the Organisational Strategic Plan (OGS), the Asset Management Policy, the Strategic Asset Management Plan (SAMP), and the Asset Management Plans (AMPs) (International Organization for Standardization, 2014). The alignment between these elements is vital to a successful System and is further described in Figure 2.3.

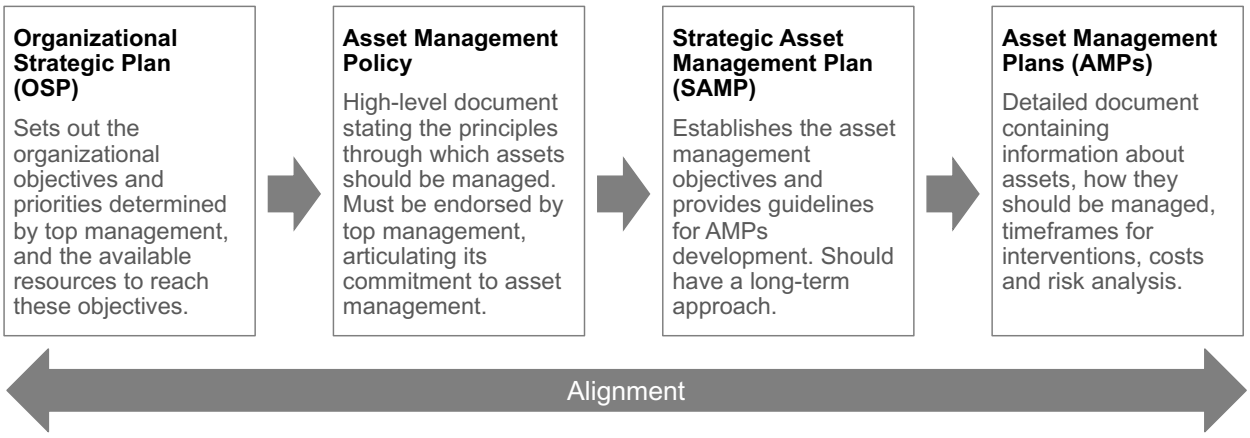

Figure 2.3: Concept of Asset Management System alignment, as detailed in ISO 55002.

In conclusion, the ISO 55000 series provides a powerful framework for AMS implementation and, as a consequence, is the most accepted asset management international standard. These standards influence the development of so many other frameworks, particularly the GFMAM's Landscape, the IAM's Anatomy and NAMS & IPWEA's IIMM, described in the following sections of this literature review.

2.5.2. GFMAM's Asset Management Landscape and IAM's Asset Management Anatomy

The Asset Management Landscape is a document developed by the Global Forum on Maintenance and Asset Management (GFMAM) with the goal to consolidate and align knowledge about the asset management discipline to its member organizations. Its first version was released in 2011, with a second reviewed version published in 2014, to consider the ISO 55000 series framework.

The Landscape framework is composed of three areas that represent the degrees of flexibility organizations have concerning asset management practices. First is the "supporting area", encompassing standards and other knowledge that are outside the scope of asset management but might still influence asset management practices. These standards likely vary from country to country and organization to organization and must be considered in the AMS. Second is the "knowledge and practices" area, representing the specific practices defined by each GFMAM member or organization around the world regarding their own asset management frameworks (Global Forum on Maintenance and Asset Management, 2014).

Last and most important is the "core" area, which encompasses the asset management fundamentals and the 39 asset management subjects. The fundamentals are defined by clause 2.4.2 of ISO 55000 and are value, alignment, leadership and assurance, whereas the 39 subjects provide an understanding of the asset management scope. GFMAM claims that these subjects result from an extensive review of international asset management models and approaches (Global Forum on Maintenance and Asset Management, 2014). Figure 2.4 shows the asset management landscape framework.

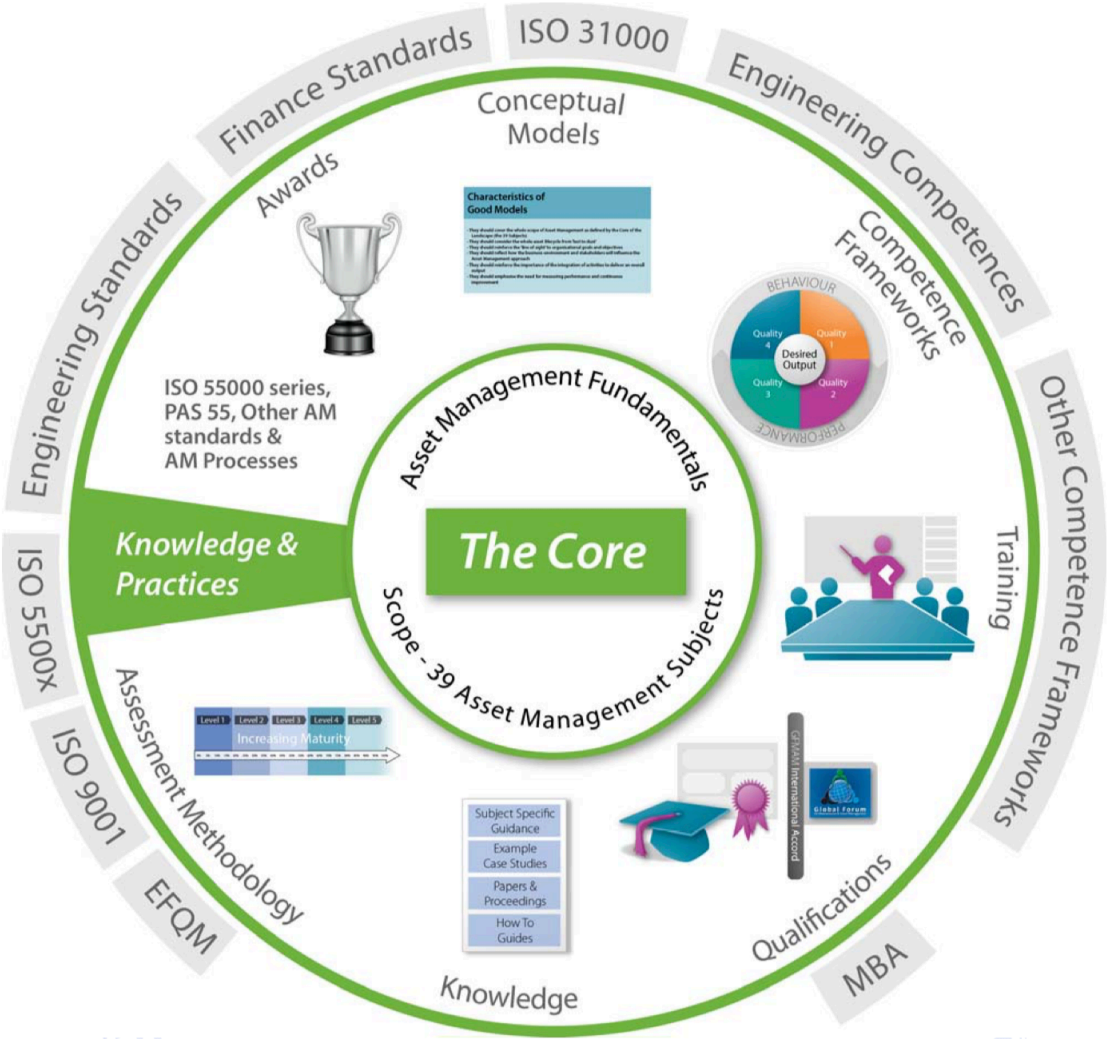

Figure 2.4: Asset Management Landscape framework. Source: The Asset Management Landscape.

The 39 asset management subjects are described, one per page, in the Landscape document. Each page brings a subject title; its definition; a context for subject application; artefacts or the subject relevant documents, processes and plans; the relation to the other subjects; and relevant standards. What this document does not do, is to provide a holistic approach and integrated view of these 39 subjects. This is done in the Asset Management Anatomy document.

The third version of the Asset Management Anatomy was published in 2015 with the intention to help not only organizations but also individuals to improve their asset management capabilities. This document was developed by the Institute of Asset Management (IAM) and is

fully integrated with both the ISO 55000 series and the Landscape. In this context, asset management was clearly positioned as a discipline, where the 39 subjects were divided into six inter-related subject groups, according to Figure 2.5 and Figure 2.6.

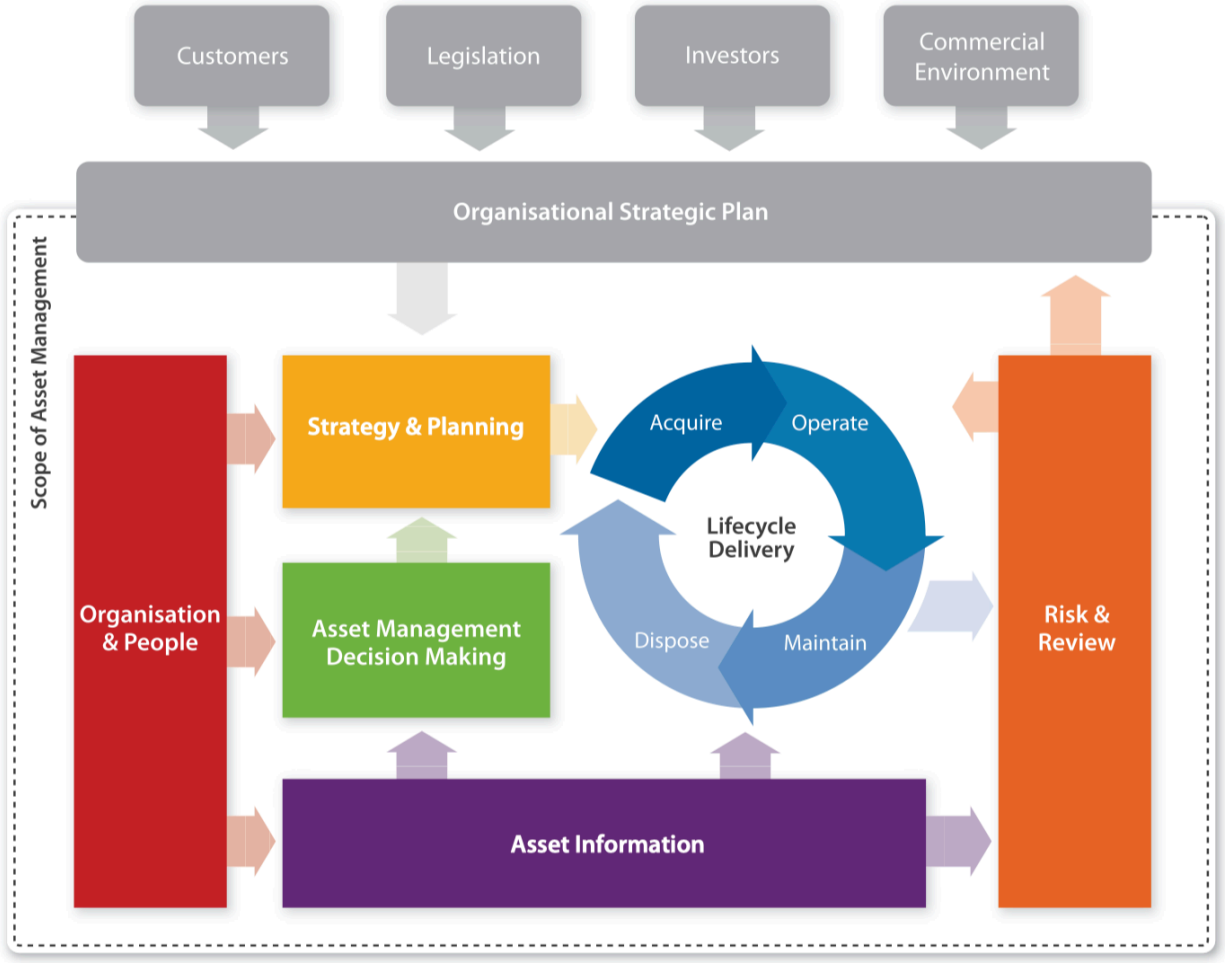

Figure 2.5: The IAM's conceptual Asset Management model. Source: IAM's Asset Management Anatomy.

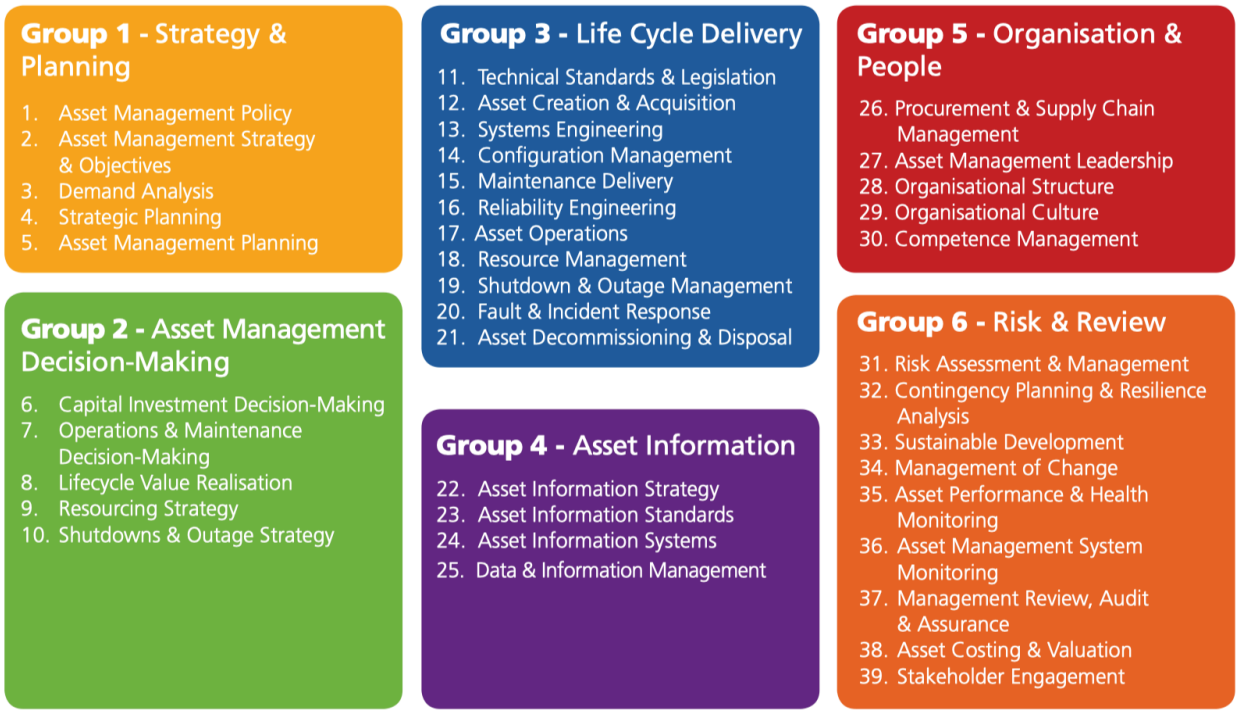

Figure 2.6: Alignment of the 39 Asset Management Landscape subjects with the six subject groups. Source: IAM's Asset Management Anatomy.

Group "1" subjects, in yellow, represent Strategy and Planning and are focused on the core documents of the AMS and on demand analysis. The outputs of this group feed into Life Cycle Delivery activities. Decision-making related subjects, in green, are the focus of Group "2", including capital investment and operations & maintenance decision processes, resourcing and shutdown strategy, and life cycle value realisation. Group "2" outputs guide Strategy and Planning subjects. Life Cycle Delivery encompasses specific technical processes to asset acquisition, operation, maintenance and disposal, and form Group "3" subjects, in blue (The Institute of Asset Management, 2015). Groups 1 to 3 constitute the central subjects of the Anatomy's framework.

Equally important, Groups 4 to 6 represent the supporting processes. Asset information constitutes Group "4" – in purple, which includes processes for determining the information that should be collected and how it should be collected, analyzed and distributed; further knowledge on setting information systems; and key aspects of asset information storage, management and distribution. According to the Anatomy, the management of information should be treated with

the same diligence as the management of assets. Organization and People, in red, form Group "5", and besides introducing procurement and leadership processes, it focuses on organizational structure, culture and competence management. Finally, Group "6" Risk and Review – in orange – brings a risk approach to the management of assets by touching on crucial subjects such as contingency planning and resilience analysis. Other key miscellaneous processes include management of change, sustainable development, and asset costing and valuation.

In summary, the Anatomy and the Landscape are complementary frameworks that offer some useful guidance to the implementation of an AMS. They build on the ISO 55000 series by bringing a more technical approach, especially to life cycle delivery processes. Qualitative and quantitative asset information management are presented as the System's cornerstone. One of the best features of the Anatomy is detailing how the subjects fit together by highlighting the holistic nature of the discipline. Nevertheless, these documents still miss a more practical approach on the "how to" of asset management, which admittedly, was never their intention to provide.

2.5.3. International Infrastructure Management Manual

The International Infrastructure Management Manual (IIMM) was developed by the Institute of Public Works Engineering Australia (IPWEA) and the New Zealand National Asset Management Support Group (NAMS). Although its fifth and most current version was published in 2015, the document available for this literature review was a 2011 version. According to the free supplement of the 2015 edition, the main change to the current version is the alignment with ISO 55001 requirements (Institute of Public Works Engineering Australasia, 2015).

Aiming to offer in-depth guidance on how to implement asset management, this manual describes, in more than 300 pages, the best practices for achieving this goal. It also provides over 110 case studies distributed among the sections, with practical insights on each topic. The manual is divided into five sections, with the core sections reviewing in detail the asset management practices for each process. Section 1 brings an introduction to asset management, while Section 5 discusses specific issues of six countries, including Canada. Figure 2.7 depicts the asset management processes according to the IIMM's framework.

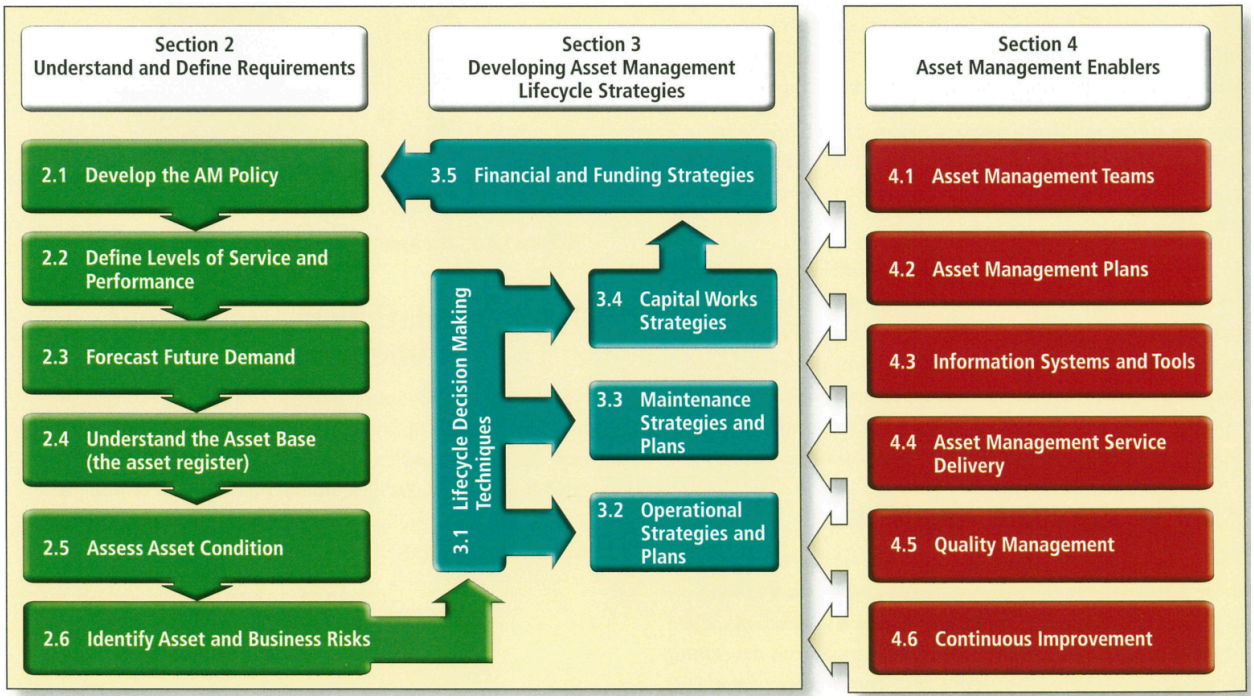

Figure 2.7: The IIMM's asset management processes. Source: IIMM 2011.

Section 2 is dedicated to understanding and defining asset management requirements, starting with the Policy. Then, it presents Levels of Service (LoS) as the centrepiece of asset management, as it entails understanding what customers require and are willing to pay for. This is one of the few frameworks that give actual guidance on how to define LoS and performance indicators. Demand forecast and a reliable asset base connected with asset condition provide a solid ground for asset management decisions. Finally, risk identification is key for a comprehensive approach (IPWEA & NAMS, 2011).

Alternatively, Section 3 processes focus on life cycle strategies and planning. Decision-making techniques are presented, in addition to operational, maintenance and capital works strategies. Important aspects for crisis and emergency planning are considered in the operational strategies and plans topic. Notably, the maintenance strategies topic is very detailed and offers an in-depth view for professionals that lack knowledge in this area. The last process, financial and funding strategies, provides a solid base for developing both the asset register and the financial plan for the AMP (IPWEA & NAMS, 2011).

Asset management enablers are discussed in Section 4. The asset management team topic brings a very practical approach on team structure, capability requirements, and on the definition of roles and responsibilities. It is important to highlight that AMPs are considered a discipline enabler. IIMM is not prescriptive about the Plan structure, but it offers an example of a detailed AMP outline. Concerning this topic, the necessary steps for AMP development are more relevant than its structure. In contrast, processes 4.5 and 4.6 show considerable alignment with ISO 55000 series, given they indicate that the AMS should be integrated with the Quality System and that organizations should strive for System's continuous improvement. Processes 4.3 – information systems and 4.4 – service delivery are also discussed, with the latter providing a brief overview of procurement methods (IPWEA & NAMS, 2011).

Another strong suit of the IIMM is the asset management maturity index, as depicted in Figure 2.8. The index brings, at the beginning of each topic, a brief description of the minimum, core, intermediate and advanced asset management practices. Organizations making use of the manual can select the best practice level, knowing that it is not always beneficial to aim for advanced practices. The organizational context and maturity level should be considered when deciding which status to adopt. As an alternative use, the maturity index could help organizations to assess their current asset management practices and set a goal for each process.

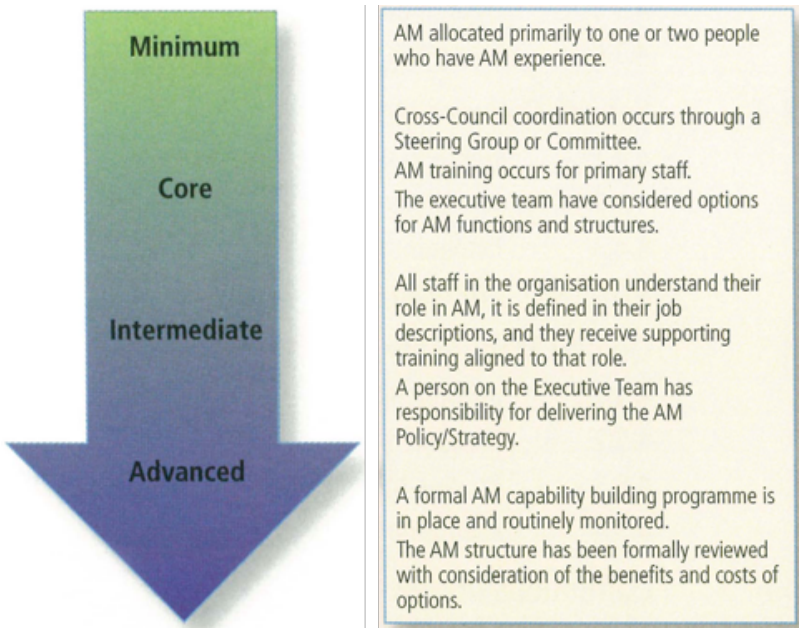

Figure 2.8: Asset management maturity index - process 4.1 example. Source: IIMM 2011.

Coupled with the alignment concept of the OSP, Policy, SAMP and AMP, is the vertical coordination through different levels of planning. For this purpose, the IIMM describes alignment through organizational lenses, considering the strategic, tactical and operational dimensions of the planning process. On the highest level, the strategic planning reflects the organization's direction and broad long-term goals while considering the organizational context, especially regarding legal requirements and stakeholder expectations. However, on IIMM's 2011 framework approach, AMPs are considered to be tactical plans, once they define the necessary activities to achieve the prescribed LoS. Operational planning is the lowest level of planning and contemplates detailed and focused short-term plans. These plans are geared towards implementation processes and are usually presented in a 1-3 year timeframe (IPWEA & NAMS, 2011). Figure 2.9 presents the levels of planning as defined by the IIMM.

Figure 2.9: Strategic, tactical and operational planning. Source: IIMM 2011.

In conclusion, the IIMM is unquestionably the best "how to" guide for asset management practices. This manual provides, at the same time, a broad view of the discipline and an in-depth analysis of asset management processes. The case studies, which are rare in comparable documents, add practical information to guide professionals on their asset management journey. Nevertheless, most of the key definitions differ from the ISO 55000 series, even in the 2015 version (Institute of Public Works Engineering Australasia, 2015). Even so, the IIMM is an important reference document for asset managers around the globe and could be used by organizations to assess their practices and improve their AMSs.

2.6. Asset Management Readiness Assessment Tools

Asset management frameworks are applied in practice through organizational AMSs that support the implementation of robust and effective processes. In the same way, processes are a structured set of activities that must be performed to achieve the organizational goals. Policies and regulations have pushed municipal water utilities to develop Asset Management Plans and Strategic Asset Management Policies. However, these legislative requirements cannot guarantee that effective processes to manage assets are in place.

With that in mind, several asset management organizations developed tools to assess the industry's practices, known as maturity or readiness assessment tools. The objective is to classify asset intensive organizations according to a readiness scale that indicates how advanced they are on their journey. For that purpose, assessment is performed against a set of selected processes and desired outcomes, representing important practices to good asset management.

Assessing organization's practices using a structured and objective approach could help setting a baseline and facilitate progress measure over time. Additionally, as a readiness assessment requires staff input from different departments and organizational layers, it builds awareness and supports integration across departments. Ultimately, readiness assessments determine areas of strength and areas that require improvements, which is key for establishing priorities to the asset management system. According to Amaral, Alegre and Matos (2017), opportunities to explore and benchmark infrastructure asset management practices in the water sector should be encouraged.

Therefore, the purposes of this section are to identify relevant processes and methods that asset management organizations have developed to assess industry's practices, and to determine their fitness to assess municipal water utilities in Ontario.

2.6.1. Asset Management BC's AssetSMART

Asset Management British Columbia (AMBC) is a community of practice that provides a series of asset management resources to municipalities. They have developed their own asset management framework, the "Asset Management for Sustainable Service Delivery: A BC Framework" – depicted in Figure 2.10, which provides the elements for the AssetSMART 2.0 assessment tool (Asset Management British Columbia, 2015).

Figure 2.10: Asset Management for Sustainable Service Delivery: A BC Framework. Source: Asset Management British Columbia (2015).

For AMBC, the pillars of asset management are People, Information, Assets and Finances. These four core elements hold 21 key high-level aspects that together provide the asset management big picture of a municipality. All key aspects are numbered, from 1 to 21. Figure 2.11 depicts the four core elements and the 21 key aspects of the AssetSMART 2.0 assessment tool.

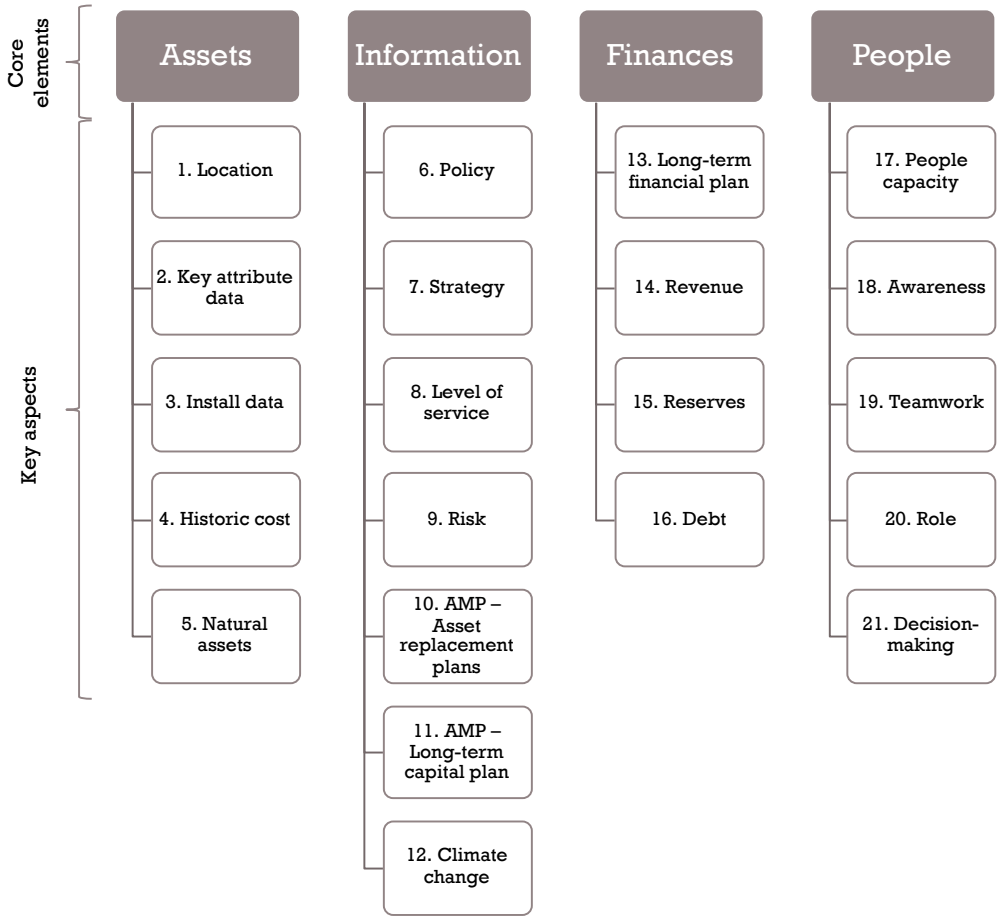

Figure 2.11: Core elements and key aspects of the AssetSMART 2.0 assessment tool.

The AssetSMART assessment methodology places municipalities in four levels of maturity, starting from Level 1 – very low capacity; Level 2 – fair capacity; Level 3 – good capacity; and Level 4 – high capacity. These levels are represented by descriptors on each row across the 21 key aspects. Figure 2.12 illustrates an example of key aspects and descriptors for the Information core element.

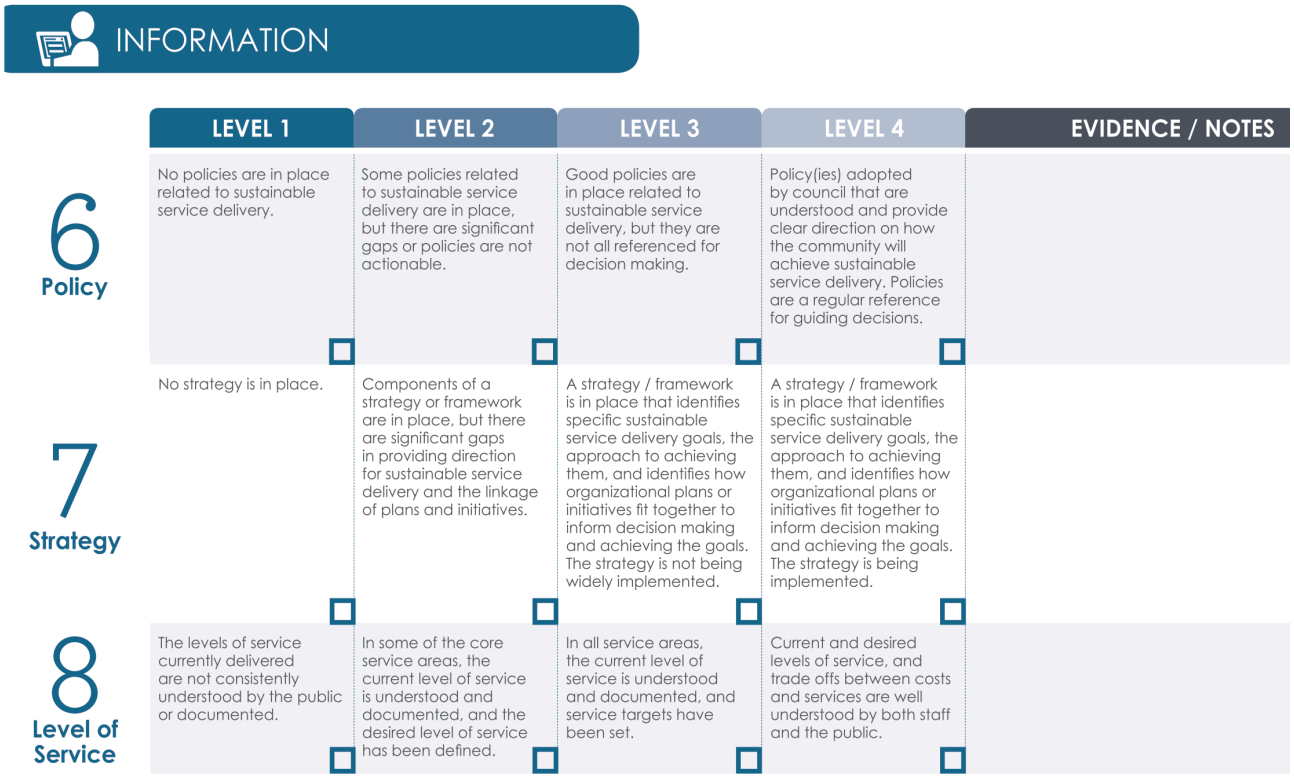

Figure 2.12: Example of key aspects and level descriptors for the Information core element. Source: AssetSMART 2.0, from Asset Management British Columbia (2015).

The five key aspects encompassed by the Assets core element focus mostly on asset data accurateness, completeness, availability and accessibility. Considering level descriptors make use of some imprecise terms, there could be some flexibility on the level placement by municipalities performing self-assessment. The last key aspect highlights the integration of natural assets to asset planning and decision-making.

In contrast, the Information core element is very broad and uses concepts of the BC Framework, which are not necessarily integrated with the ISO 55000 series framework. Notably, strategy and framework are used as synonyms, whereas AMPs refer to asset replacement plans and long-term capital plans. Climate change, risk and levels of service are fortunately brought to attention as key aspects, which is rarely the case for other assessment tools.

Unfortunately, the Finances core element tends to focus on the state of finances, e.g. having sufficient and reliable revenue, instead of focusing on the processes that support finances and its

connection to asset management. To that extent and for the purpose of a readiness assessment, it is more important to have practices in place to identify and deal with debt levels than stating that current debt levels are healthy. Therefore, the four key aspects encompassed in Finances might not reflect the actual processes used for managing assets from this perspective.

The key aspects included in the People core element reflect important aspects for the success of an asset management program in any organization. The only exception would be Item 21, decision-making, which could be better represented in another core element. Certainly, decisions are made by people, but asset management decisions should be objective and supported by a prioritization process and by financial and technical information.

Ultimately, this tool requires some knowledge regarding the BC framework, as the methodology glossary provides a limited review of terms. The 21 key aspects, although significant, give only a high-level view of asset management practices, not fitted for organizations that are more advanced on their journey. Interpretation of level descriptors are somewhat subjective, which could hinder assessment results and benchmarking. Most seriously is the level classification, as it is clear that the minimum conditions for good asset management practices are given by Level 4. Still, the consideration of risk, climate change, natural assets and levels of service are very positive.

2.6.2. FCM's Asset Management Readiness Scale

The Municipal Asset Management Program (MAMP) team, from the Federation of Canadian Municipalities (FCM), has developed the Asset Management Readiness Scale. The first two versions of this self-assessment tool were made available to municipalities in 2016/2017, with a third and slightly improved version shared in 2018.

Assessments are run based on five core or competency areas, namely, policy and governance, people and leadership, data and information, planning and decision-making, and contribution to asset management practice. These competencies, in FCM's view, represent the building blocks of the asset management practice (Federation of Canadian Municipalities, 2017). Each competency contains three outcome areas, as depicted in Figure 2.13.

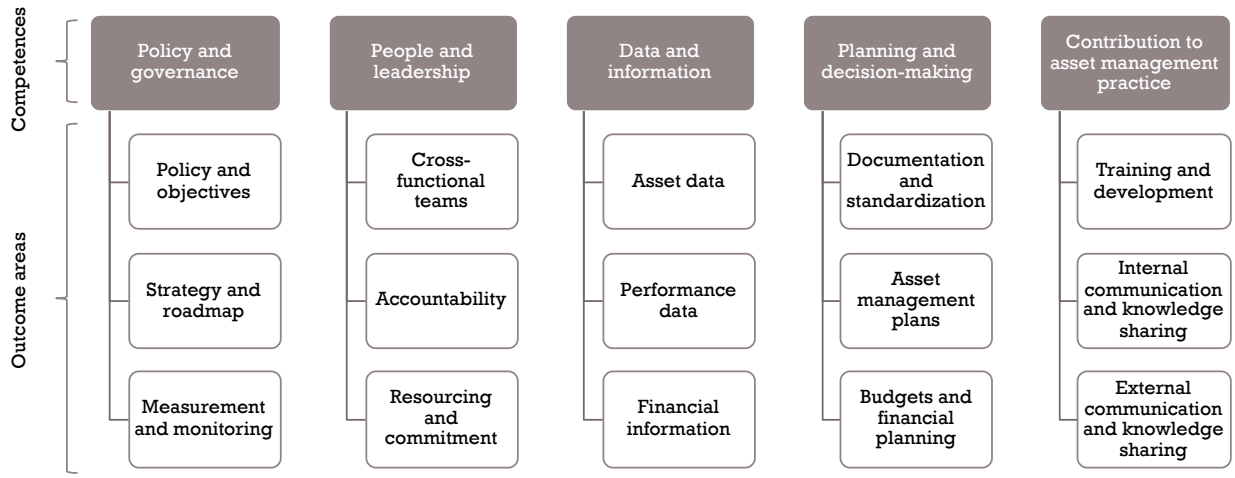

Figure 2.13: FCM's competences and outcome areas (2018 version).

To perform the self-assessment, organizations must acknowledge the specific outcomes they have achieved under each outcome area and competency. A six-point scale indicates the asset management readiness levels, varying from 1 to 5. An additional level called "Working on Level 1" implies that the assessed municipality has not yet reached the minimum criteria to be classified in Level 1. Figure 2.14 presents the assessment sheet for the people and leadership competency, from FCM's Asset Management Readiness Scale.

People and leadership

By developing this competency, your organization is setting up cross-functional teams with clear accountability and ensuring adequate resourcing and commitment from senior management and elected officials to advance asset management.

	Outcomes: Select the outcomes that your organization has achieved.				
Outcome areas	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
A **Cross-functional teams**	☐ We have identified the representation we need on our cross-functional **AM team**.	☐ We have a cross-functional **AM team*** that guides the planning and implementation of our **AM program**.	☐ Our **AM team*** works within our organization to lead, communicate, and support AM improvements and organizational changes.	☐ Our **AM team*** is permanent and tasked with guiding and supporting AM across the organization on an ongoing basis.	☐ Our **AM team*** guides and supports the ongoing improvement of AM within the organization.
B **Accountability**	☐ We have a champion who has been tasked with planning for our **AM program**.	☐ Our **AM team*** has a documented mandate to develop our **AM program**, which is outlined in a terms of reference and a one- to three-year **roadmap**. ☐ Our **AM team** is accountable to senior management and council.	☐ Our **AM team*** is accountable for implementing our **AM program**. ☐ AM roles and responsibilities are included in staff job descriptions.	☐ We have operationalized AM roles and responsibilities across our organization.	☐ We document changes to AM roles and responsibilities as needed to support our evolving requirements.
C **Resourcing and commitment**	☐ Council knows that resources must be dedicated to exploring the requirements for **AM** and for drafting an **AM roadmap**.	☐ Council demonstrates buy-in and support for AM and allocates resources (funding or staff time) to further develop the **AM program**.	☐ Council champions AM as a core business function and has approved funding to continue **AM roadmap** activities.	☐ Council funds ongoing AM monitoring and enhancement.	☐ The **AM team** measures and monitors progress. ☐ Council demonstrates commitment to ongoing improvement of AM practices.

Readiness level: You have achieved a readiness scale level when your organization can demonstrate achievement of all outcomes for that level.

Readiness level	**Working on Level 1** ☐	**Completed Level 1** ☐	**Completed Level 2** ☐	**Completed Level 3** ☐	**Completed Level 4** ☐	**Completed Level 5** ☐

Figure 2.14: People and leadership competency sheet. Source: FCM Asset Management Readiness Scale (2018).

Overall, this methodology is simple and straightforward, yet it focuses on the key points that constitute a good AMS. The main asset management concepts are described in FCM's Readiness Scale document, facilitating understanding and preventing misinterpretation of terms (Federation of Canadian Municipalities, 2017). One of the greatest strengths of this tool is that it does not require extensive asset management knowledge from municipalities, allowing low readiness level organizations to assess themselves accurately. Table 2.1 demonstrates the key concepts encompassed by the outcome areas.

Table 2.1: Asset management key concepts encompassed by outcome areas.

Competences	Outcome areas	Key asset management concepts
Policy and governance	Policy and objectives	AM policy, AM objectives, AM system
	Strategy and roadmap	AM strategy, roadmap, AM practices
	Measurement and monitoring	Performance measures to the AM system, AM practices
People and leadership	Cross-functional teams	Cross-functional AM teams
	Accountability	Accountability, roles and responsibilities
	Resourcing and commitment	Resourcing, commitment from senior management and elected officials
Data and information	Asset data	Asset inventory data, asset condition assessment, asset criticality, life cycle investment requirements
	Performance data	Levels of service
	Financial information	Identification of infrastructure funding gaps, asset life cycle cost information
Planning and decision-making	Documentation and standardization	Asset planning approach (priorities' setting)
	Asset management plans	Broadness of asset management plans
	Budgets and financial planning	Capital plans, operating budgets, long-term financial plans
Contribution to asset management practice	Training and development	Approach and requirements
	Internal communication and knowledge sharing	Knowledge sharing culture and resources
	External communication and knowledge sharing	AM organizations and events

Because this tool was designed with Canadian municipalities in mind, some concepts might diverge from the international asset management vocabulary. For example, in many cases, the term

“asset management program” is employed as a synonym to “Asset Management System”. The concepts for Asset Management Policy and Strategy diverge from what is presented in the ISO 55000 series. Additionally, “financial information” is used to express “asset life cycle cost information”. Nevertheless, FCM’s Readiness Assessment Scale provides a high-quality tool to identify current asset management practices and improvement opportunities.

2.6.3. IAM’s Self-Assessment Methodology Plus

Aiming to provide an advanced self-assessment tool to organizations, the Institute of Asset Management (IAM) made available in 2015 the second version of its assessment tool, the Self-Assessment Methodology Plus (SAM+). This is a three-in-one tool, as it enables organizations to assess their practices against three distinct frameworks: ISO 55000, PAS 55, or the Asset Management Anatomy and its 39 subjects (The Institute of Asset Management, 2015).

Coincidentally, both the ISO 55000 and the Anatomy assessment forms have 39 questions each. Nevertheless, the former asks 87 sub-questions and the latter presents 316 criteria embedded on their questions to further determine organizations’ maturity levels. The PAS 55 assessment will not be reviewed, given that communities of practice have recommended organisations applying this framework to transition to ISO 55000 standards (British Standards Institution UK, 2014).

The maturity scale in this methodology is the same for the ISO 55000 and the Anatomy assessments and comprises five levels. Level 3 indicates conformance with ISO 55001’s requirement clauses and the Anatomy’s 39 asset management subjects. In contrast, Levels 4 and 5 were grouped and are called “Beyond”, but level descriptors are not available in this assessment tool. The “Beyond Level” must be selected when the organisation understands that its processes and practices surpass the frameworks’ recommended standards. Figure 2.15 shows the SAM+ maturity scale.

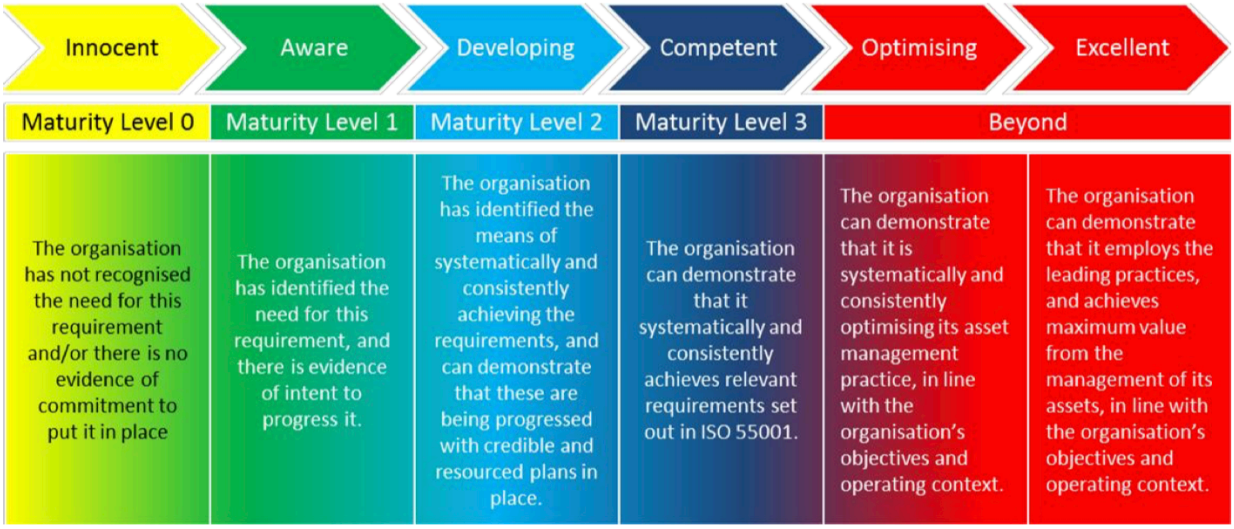

Figure 2.15: Self-assessment Methodology Plus maturity scale. Source: IAM's Self-Assessment Methodology Plus guide.

Readiness assessment is executed through a Microsoft Excel software tool, copyrighted to the IAM. After selecting the assessment framework, one should start by reading Level 3 descriptors, or the sub-questions that describe Level 3 as is the case for the ISO 55000 form, subsequently determining if it fits with the organization's practices. If it does not, the other levels descriptors should be evaluated, from Level 2 to 0, and the best fit should be selected accordingly. After the assessment has been completed, results are displayed in a radar chart and a bar chart. To clarify the process understanding, Figure 2.16 provides the SAM+ assessment form for ISO 55000. The Asset Management Anatomy form is very similar to the one presented here.

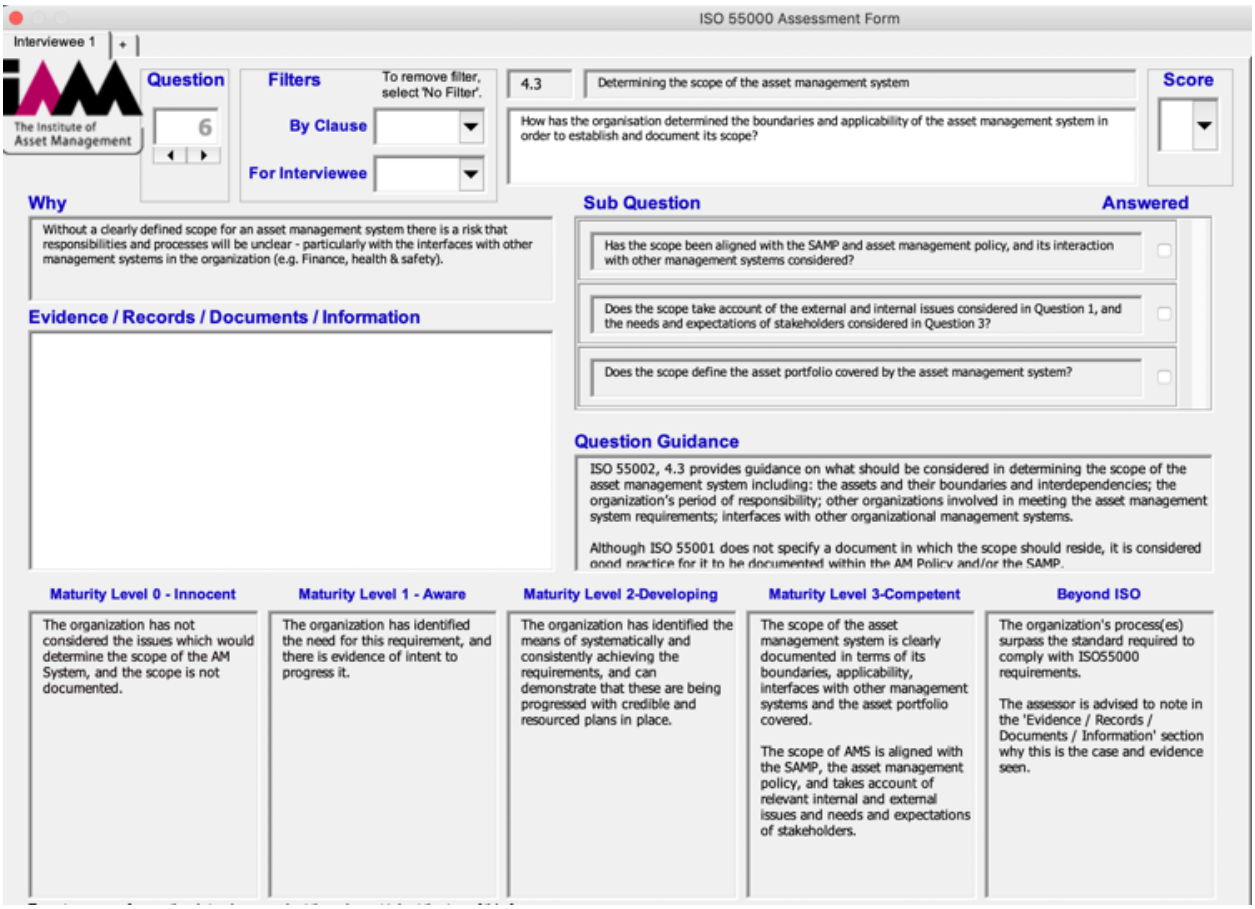

Figure 2.16: Self-assessment Methodology Plus form for ISO 55000. Source: SAM+ Excel tool.

In conclusion, this tool provides a detailed maturity assessment against both the ISO 55000 requirement clauses and the 39 subjects of the Asset Management Anatomy. The assessor must be experienced and have previous knowledge of these frameworks' processes and requirements. Although the number of questions is not too large, analyzing the sub-questions and criteria to correctly assess an organization might be time-consuming. As a result, this tool could be more beneficial to organizations that have an AMS already in place, or that are advanced in their asset management journeys and are working on the AMS implementation.

2.7. Relevant Asset Management Studies

To provide effective guidance and training, communities of practice need information on how advanced municipal water utilities are in implementing asset management practices and processes. Similarly, policy makers must align their expectations with the reality of how fast municipalities are able to implement asset management regulatory requirements. Additionally, several instances of government have to correctly determine funding and push for the necessary support to be in place.

Therefore, there is an ample need to collect data on asset management processes and practices, and to make this data available to interested stakeholders. This Section provides an overview of such studies, focusing on the type of information collected and not on the data per se. It is important to keep in mind that studies that have collected mainly state of infrastructure data, e.g. asset condition ranking, replacement value and investment rate, were already reviewed in Section 2.2 and will not be commented here.

The 2016 Canadian Core Public Infrastructure (CCPI) survey asked few questions about asset management processes. The existence of an AMP, its updating frequency and the type of information system used by organizations – whether software, spreadsheet or paper records, were the main questions that did not concern asset ownership. Moreover, the asset classes that considered climate change adaptation into decision-making process were encompassed (Statistics Canada, 2018).

In contrast, the 2016 Canadian Infrastructure Report Card (CIRC) focused on the source and technology used to determine condition information, the timeframe for the condition assessment cycle, and the existence of AMPs and Asset Management Systems. Further, it explored whether risk assessment was undertaken and if a formal process was in place to consider climate change in asset decision-making (Federation of Canadian Municipalities, 2016). As the 2019 CIRC analyzed the data collected by Statistics Canada in the 2016 CCPI survey, there was no new information added.

The “Leveraging Asset Management Data for Improved Water Infrastructure Planning” survey report was developed by the Public Sector Digest (PSD), the Canadian Water Network (CWN) and the Canadian Water and Wastewater Association (CWWA). Its main focus was on identifying the quality of data being used to populate water, wastewater and stormwater AMPs in

Canada. The survey received 59 responses from all Provinces, where 32 of them were from Ontario. Questions concerned the reliability of condition data – objective versus subjective; the approaches for asset investment prioritization – risk-based, fiscal, etc.; the uses of asset data – to sustain performance, to optimize costs, etc.; the asset management staffing capacity and responsibilities; the frequency of AMP updates; the extension of asset inventory and replacement cost information – percentage of assets covered; maintenance approaches – reactive, preventive, predictive; and the type of data used to inform water and wastewater activities – age, number of breaks, criticality (Public Sector Digest, 2018). Although this study has focused on asset data alone, it still explored important asset management processes and practices.

Conversely, a broader approach was employed in the American Water Works Association (AWWA) 2015 report entitled "Establishing the Level of Progress in Utility Asset Management". This report displayed the survey results from 545 utilities, mostly from North America. In addition to understanding the need of water utilities for additional resources, the purpose of the study was to support them towards advancing their asset management practices. Survey questions were well structured in six distinct sections (American Water Works Association, 2015).

The General Asset Management Section asked about the existence of a dedicated asset manager or staff, whether they embrace asset management or not, the realized benefits for the discipline, and its implementation plan. Information regarding the asset registry, the use of GIS for mapping assets, and the processes for assessing linear and vertical asset condition were encompassed in the second Section – Current State of the Assets. The third Section, Levels of Service, explored LoS documentation and target definition, in addition to demand analysis. The Risk Management Section inquired about the processes for assessing the likelihood and consequence of asset failure, asset ranking according to overall risk, and prediction for water distribution pipe proactive replacement. Section Five, Maintenance and Reliability, concerned reactive versus planned maintenance practices, a specific question about predictive maintenance practices, and the use of Computerized Maintenance Management Systems (CMMS). Finally, the existence of an AMP and the use of business case evaluation for infrastructure investment decisions were the two questions that composed the Asset Planning Section (American Water Works Association, 2015).

2.8. Summary

After gathering knowledge on the state of water and wastewater infrastructure in Canada, examining the peculiar challenges faced by water utilities when managing their assets, and assessing asset management legislative requirements, we have moved on to exploring widely known asset management frameworks and to reviewing readiness assessment methodologies and studies.

The key takeaways from this literature review are enumerated as follows:

(a) Water and wastewater infrastructure are in dire need of attention and investments, if we intend to sustain the quality of life in Canada. About 12% of this infrastructure is in poor or very poor condition, representing CA$ 51 billion in replacement value.

(b) Assessing the state of buried infrastructure through physical inspection is usually difficult and costly. Because of these high costs, pipes' condition is frequently inferred through age, a less than optimal and often misleading approach, undermining investments and planning.

(c) Ontario legislative requirements, though robust and necessary, are not always aligned with the most relevant and widely used asset management frameworks.

(d) The IIMM is an excellent manual on "how to do" asset management. Nevertheless, the ISO 55000 series provides an overarching vocabulary of terms that are used worldwide.

(e) The readiness assessment methodology selected to serve as the backbone of this study is FCM's Readiness Assessment Scale. This methodology is straightforward and focuses on the most important practices for good asset management.

(f) The relevant asset management studies reviewed in Section 2.7 have provided valuable insights on asset management processes and practices and on how to structure a survey. However, they lack a comprehensive and systematic approach to assess municipalities current asset management levels of practice, especially in Canada.

Chapter 3
Research Methodology

3.1. Overview

This chapter describes the methodology used to assess the readiness levels of Ontario municipal water utilities and the asset management practices employed by them. The rationale supporting each major methodology decision is also presented. First, the selection of a framework for the readiness assessment is reviewed. Second, questionnaire development and survey validation are discussed in detail, highlighting how the readiness assessment was embedded in the questionnaire. The approach regarding data collection, including survey promotion, distribution and challenges, is illustrated next, followed by an explanation of how scorable and non-scorable questions were analyzed. Finally, the reasons behind benchmark reporting and its characteristics are disclosed.

3.2. Development of the Water and Wastewater Asset Management Readiness Assessment Survey

The lack of information on the asset management processes adopted by municipal water utilities was the main driver for this study. Due to the extent of asset management regulations and requirements when compared to other Canadian Provinces and Territories, Ontario municipalities are expected to be more advanced on their asset management journey. As a consequence, this study focuses on establishing a reliable readiness baseline for Ontario. This task entailed the selection and tailoring of a readiness assessment methodology that was adequate to municipalities from diverse sizes and backgrounds.

As the Province is composed of 444 municipalities, a web-based survey was chosen as the data collection method. Interviews would have been biased towards large municipalities, since they have more capacity to afford the necessary time and personnel. Survey distribution approach was also key to give every municipality the opportunity to participate.

Survey development and the readiness assessment of Ontario municipalities consisted of six main phases:

(a) **Review and selection of a readiness assessment framework:** in the light of asset management guidelines and regulations, publicly available national and international readiness assessment frameworks were reviewed. The Federation of Canadian Municipalities (FCM) readiness assessment methodology was selected as the backbone for the elaboration of survey questions.

(b) **Survey development:** questions were created with the purpose of verifying the outcomes prescribed by FCM's methodology and were later grouped by sections comprising similar subjects or competency areas. Outcome complexity was the determiner to order questions in a logical progression.

(c) **Pilot phase and survey validation:** the survey was validated through a pilot sent out to key stakeholders from the government, private and public sectors. After careful consideration of all inputs and implementation of the suggested modifications, final approval was given by the project sponsor, the Ontario Water Consortium (OWC), formerly Southern Ontario Water Consortium (SOWC).

(d) **Data collection:** the first distribution strategy consisted of partnerships with communities of practice, which made the survey link available on their online platforms. Later, with the goal of expanding the number of respondents, it was necessary to develop a targeted list of water municipal asset managers. This second strategy yielded a much larger number of responses. Data collection was based on the number and diversity of respondents, using similar surveys as a benchmark.

(e) **Data analysis:** each respondent entry was reviewed, and data were cleaned with respect to survey completion. The classification of respondent municipalities followed population size according to Statistics Canada – small, medium and large municipalities – and their readiness levels were assessed respecting this categorization.

(f) **Benchmark reports:** a benchmark template was developed to reward participants with their readiness assessment scores compared to the aggregated scores of municipalities in the same size category.

Figure 3.1 shows the survey timeline, encompassing additional activities to the ones described in this chapter.

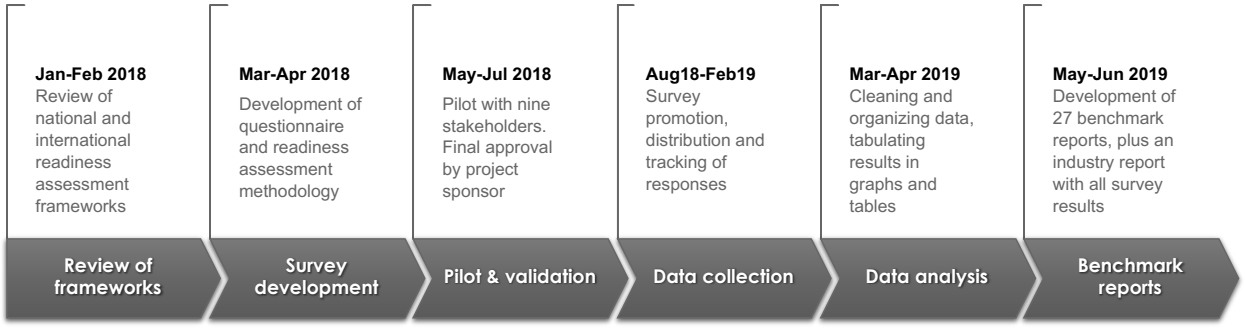

Figure 3.1: Survey timeline.

3.2.1. Survey Framework Approach

To determine the asset management readiness level in Ontario municipal water utilities, an assessment framework was developed and used to collect data through a voluntary web-based survey. The researcher reviewed three publicly available national and international readiness assessment frameworks, some containing more than 100 criteria.

The Federation of Canadian Municipalities' (FCM) Asset Management Readiness Scale (Federation of Canadian Municipalities, 2017), the ISO 55000 series (International Organization for Standardization, 2014), and the Ontario Regulation 588/17 (Ministry of Infrastructure, 2017) main requirements were adapted into a survey containing 54 questions.

FCM's readiness assessment methodology was chosen as the main framework for survey development. This framework is simple in the sense that it requires organizations to check if they have achieved specific outcomes, representing asset management practices. The fact that the outcomes are designed for a national context, are comprehensive, and can be easily understood by organizations of different sizes and backgrounds was crucial for the incorporation of this assessment methodology in the survey.

The ISO 55000 series provides an overarching approach to asset management terms and requirements. In this sense, it brings the necessary alignment with international asset management practices. In survey development, the standards guided the definition of important terms and equalized requirements' understanding for respondents.

In contrast, Ontario Regulation 588/17 put asset management requirements in a Provincial context and brought a regulatory perspective to the survey. Additionally, this regulation focuses on the importance of considering climate change in asset management planning and implementation, which is crucial to build asset resilience and adaptability.

3.2.2. Questionnaire's Development

The survey core questions originated from the competency outcomes of FCM's readiness assessment methodology. They not only have the purpose of identifying whether a determined outcome has been achieved, but also of measuring the extent it has been implemented. For example, question eight asks municipalities if they have an Asset Management Plan (AMP), to which they can indicate that: i) they do not have one; ii) do not have an AMP but are planning to develop it; iii) have an AMP but it is not considered in the decision-making process; iv) sometimes decisions are based on the AMP; v) the AMP is fully integrated with the decision-making process. Consequently, by answering 27 core questions, municipalities are placed in a readiness scale. These questions are here called "scorable".

From the remaining questions – the "non-scorable" questions, two considered the processes for tackling the ON Reg. 588/17, especially the aspects of climate change taken in consideration in asset management planning. Ten questions checked the perceived asset management value, previous completion of a readiness/maturity assessment, and collected additional information about AMPs, asset data and funding gaps.

The first survey distribution strategy was based on survey links being offered in communities of practice's online platforms. Therefore, it was necessary to identify municipalities' size and scale, determining which assets these organizations were responsible for, their characteristics and estimated replacement value. Ten questions were placed with these purposes. It was also important to verify whether the survey respondents were truly accountable regarding

the management of assets in their municipalities, and if they were interested in receiving the benchmark report, which was carried out in five questions.

After questions development, they were grouped into seven main sections, including five sections comprising FCM's competency areas: i) background; ii) strategic vision and AMP; iii) policy and governance; iv) people and leadership; v) data and information; vi) planning and decision-making; and vii) contribution to asset management practice. The background section was divided into three parts throughout the survey – background questions, specific background questions and identification of target population. Questions were arranged by increasing outcome complexity and often had term definitions to guarantee the alignment in interpretation among respondents.

SurveyMonkey was the chosen tool for online survey application. This tool allows a good level of survey customization and control for an affordable price. Several features to reduce the time spent answering questions were used, since the survey was a bit long. First, an easy-to-read design was developed, where questions and definitions had a different color and font size from the alternatives. Second, each questionnaire page contained one section of the survey – to reduce the number of clicks to the next question – and a progress bar. The progress bar was added after the pilot phase, where one of the stakeholders reported being anxious for not knowing when the survey would end. Finally, answers from each section were automatically saved, and respondents could always go back to the survey, as long as they used the same electronic device.

Three question types were employed: multiple choice for 83% of questions, "mark all that apply" for 11%, and matrix for 6%. With very few exceptions, questions had an "I am not sure" alternative and, where appropriate, a "does not apply" alternative. Furthermore, comment boxes were provided for 47 questions in an effort to capture extra information. Appendix A provides the complete questionnaire, while Table 3.1 depicts questions' organization by section.

Table 3.1 : Questions' organization by section.

Section	Number of questions	Number of scorable questions	Function
Background Questions	4	1	NSQ: identify size, tier and services provided by the municipality SQ: identify outcome for people and leadership competency area
Strategic Vision and Asset Management Plan	13	7	NSQ: collect asset management information regarding value, previous maturity assessments, AMPs, and Reg. 588/17 SQ: identify outcomes for policy and governance, planning and decision-making, and data and information competency areas
Policy and Governance	4	4	SQ: identify outcomes for policy and governance competency area
People and Leadership	4	4	SQ: identify outcomes for people and leadership competency area
Data and Information	6	4	NSQ: collect information on asset inventory confidence and tools for managing assets SQ: identify outcomes for data and information competency area
Planning and Decision-making	7	3	NSQ: collect information on Reg. 588/17, funding gaps and user fees SQ: identify outcomes for planning and decision-making competency area
Contribution to Asset Management Practice	4	4	SQ: identify outcomes for contribution to asset management practice competency area
Specific Background Questions	7	0	NSQ: identify services provided by the municipality as well as asset length and value
Identification of Target Population	5	0	NSQ: insure respondent has asset management responsabilities and verify if they want to receive the benchmark report

NSQ: non-scorable question
SQ: scorable question

3.2.3. Survey Pilot

After the development phase, the survey was sent out to nine stakeholders to be pilot tested. These stakeholders comprised the government (Ministry of Infrastructure, Federations of

Canadian Municipalities, Association of Municipalities of Ontario), communities of practice (Asset Management Ontario, Centre for Advancement of Trenchless Technologies), the private sector (two consultancy companies), and the public sector (two Ontario municipalities).

Modifications were implemented based on stakeholders' feedback to each question and on the time for survey completion. The main adjustments included adapting some of the alternatives, improving term definition, and the exclusion of some questions. The inputs provided by these stakeholders helped to keep the survey straightforward and consistent.

Once all adjustments were performed, the new version was submitted to the project sponsor – the Ontario Water Consortium (OWC) – for approval and validation. The final version of the questionnaire was 54 questions long and took on average 35 minutes to be completed.

3.3. Data Collection and Analysis

The asset management readiness level of Ontario municipal water utilities was determined through a structured framework designed for a web-based survey. The 444 Ontario municipalities own 665 drinking water systems and 466 wastewater systems (Association of Municipalities Ontario, 2016). As a consequence, the number of survey responses and the diversity in terms of municipalities' size, region and tier position were key for survey success.

Some of the most significant – and non-mandatory – asset management studies performed in Canada and Ontario served as parameters for the survey response goal. These studies are shown in Table 3.2, and from this data it was established that 30 responses with a representativeness of 50% of the Ontario population were the minimum target for this survey.

Data collection was carried out over a period of six months, from the end of August 2018 until mid-February 2019. During this time, it was necessary to modify the distribution strategy from open promotion in communities of practice online platforms to focused email list, extending the data collection period.

Table 3.2: Relevant asset management surveys performed in Canada and Ontario.

Studies / Surveys	Organizations	Number of ON Municipalities (respondents)	Equivalent population	% in relation to ON total population	Survey team / Advisory committee (# of people)	Survey response rate
Canadian Infrastructure Report Card 2016	Federation of Canadian Municipalities, Canadian Construction Association, Canadian Public Works Association, Canadian Society for Civil Engineering	36	9,436,000	70.2%	27	10%
Leveraging Asset Management Data for Improved Water Infrastructure Planning 2018	Public Sector Digest, Canadian Water Network, Canadian Water and Wastewater Association	32	N/A	N/A	20	N/A
The State of Ontario's Water and Wastewater Infrastructure 2018	Ontario Sewer and Watermain Construction Association	30	3,987,430	29.6%	N/A	N/A

3.3.1. Survey Distribution and Challenges

The purpose of the survey distribution strategy was to maximize the number of complete responses for the "Water and Wastewater Asset Management Readiness Assessment Survey". Furthermore, it was essential to reach the target population of respondents – the asset managers of Ontario municipal water utilities.

A questionnaire containing 54 questions is considered to be a bit long; hence, clearly explaining the purpose of the study, the use of data, and providing a compensation for respondents' efforts – the benchmark report – lead to high response rates. The introductory text to the survey is provided on Appendix B. The same message was conveyed in feature articles for survey promotion and in the email invitation to the focused distribution list.

The initial distribution strategy was to give access to the survey through the online platforms of communities of practice. From the 12 national and provincial organizations contacted, seven agreed to publish either a feature article or a summary about the study, along with the survey link. Table 3.3 displays the organizations that have helped with survey promotion and the online platforms used.

Table 3.3: Organizations supporting survey promotion.

Organizations	Online platforms
Ontario Water Consortium (OWC)	Feature article published on OWC's website under the news section
Ontario Water Works Association (OWWA)	Short version of feature article published on OWWA's website under the news section
Water Canada (WC)	Feature article published on WC's website under the news section
Centre for Advancement of Trenchless Technologies (CATT)	Feature article published on CATT's website under the news section
Canadian Network of Asset Managers (CNAM)	Research blurb published on CNAM's website under the news section
Canadian Water Network (CWN)	Twitted research blurb
Canadian Water and Wastewater Association (CWWA)	Feature article published on CWWA's website on monthly eBulletin

Despite these efforts, the online channels produced only four complete answers. Survey fatigue in the water sector is prominent, and it became essential to devise a new distribution strategy. According to the University of Waterloo's Survey Research Centre (SRC), targeted email distribution lists usually yield more responses than open links (SRC, 2018).

At the end of September 2018 and during October of the same year, the researcher compiled an email list containing 138 contacts of professionals responsible for managing water assets in Ontario municipalities. This list did not target any particular sample of municipalities; instead, it was aleatory. In possession of the Census data for the 444 Ontario municipalities and through their websites, asset managers were located. When contacts were not displayed on the websites, LinkedIn and free search were also used. It is important to highlight that it was fairly easy to determine the professionals responsible for asset management in each municipality, but particularly difficult to locate their email contacts. This task was extremely time consuming, taking at least 15 minutes to find and register each contact.

As the survey was voluntary, it is reasonable to assume that the participant municipalities would be minimally interested in asset management and, for this reason, might have a higher average readiness level than the total sample of 444 municipalities.

3.3.2. Data Analysis

Essentially, there are two types of questions in this survey: scorable and non-scorable. Scorable questions determined the readiness levels and scores of municipalities, while non-scorable questions provided extra asset management insight and background information. Given that 87% of responses were obtained through the focused e-mail list, where municipalities were easily identifiable, most of the background questions became redundant and will not be addressed in this thesis.

To examine how municipality size shapes the adoption of the asset management framework, municipalities were classified according to their population size in small, medium and large municipalities. This classification follows the standard reference "Population Centre and Rural Area Classification 2016" (Statistics Canada, 2017), which states that:

- Small population centres have a population between 1,000 and 29,999
- Medium population centres have a population between 30,000 and 99,999
- Large population centres have a population over 100,000 people

The data analysis methodology for scorable and non-scorable questions is presented in the following sub-sections.

3.3.2.1 Scorable Questions

The FCM methodology comprises five competency areas: i) policy and governance; ii) people and leadership; iii) data and information; iv) planning and decision-making; and v) contribution to asset management practice. The assessment of municipalities' readiness levels and scores was determined by 27 scorable questions, which contributed heterogeneously to each competency area and aimed to identify asset management outcomes. Question distribution is depicted in Table 3.4.

Table 3.4: Scorable questions per competency area.

Competency areas	Total number of scorable questions	Questions' position
Policy and Governance	6	5, 17, 18, 19, 20, 21
People and Leadership	5	3, 22, 23, 24, 25
Data and Information	5	15, 26, 29, 30, 31
Planning and Decision-making	7	8, 12, 13, 14, 32, 34, 35
Contribution to Asset Management Practice	4	39, 40, 41, 42

The FCM methodology classifies municipalities according to the competency areas into six readiness levels: i) working on Level 1; ii) Level 1; iii) Level 2; iv) Level 3; v) Level 4; and vi) Level 5. In this research, it was assumed that municipalities would be on the lower side of the scale. For this reason, as well as to keep the survey concise, this study has considered only the outcomes for the first four readiness levels in question development, as illustrated in Table 3.5.

Table 3.5: Correspondence between FCM's readiness levels and this survey.

Readiness Levels Scale						
FCM's	Working on Level 1	Completed Level 1	Completed Level 2	Completed Level 3	Completed Level 4	Completed Level 5
Water and Wastewater Asset Management Readiness Assessment survey	Readiness Level 0 (RL 0) Not Aware	Readiness Level 1 (RL 1) Learning	Readiness Level 2 (RL 2) Developing	Readiness Level 3 (RL 3) Applying	N/A	N/A

Scorable questions were developed in such way that each question alternative represents a specific readiness level outcome in correspondence with FCM's methodology. All alternatives corresponding to the "Readiness Level 0 – RL 0" are worth zero points, along with the "I am not sure" alternative and skipped questions. The options associated with "Readiness Level 1 – RL 1"

are worth one point, with RL 2, two points, and three points for RL 3. Readiness level descriptions per competency area are presented in Table 3.6.

Table 3.6: Readiness level descriptions per competency area.

Competency Areas	Readiness Level 0	Readiness Level 1	Readiness Level 2	Readiness Level 3
Policy and Governance *"This competency involves putting in place policies and objectives related to asset management, bringing those policies to life through a strategy and roadmap, and then measuring progress and monitoring implementation over time."*	AM is not strategic for the organization. The organization does not have an AM policy, AM objectives, or an AM roadmap (necessary actions to achieve AM objectives). There is no process in place to monitor the AMP's implementation. The organization is not considering to structure an AM System.	The connection between AM and the organization's goals is not clear. The AM policy, objectives and roadmap are not well documented and communicated within the organization, and employees may face difficulties finding this information. Both the development of an AM System and the establishment of a process to monitor AMP implementation are in their early stages.	The organization's strategy and goals are well connected with AM, but resource allocation is still pending. The AM policy, objectives and roadmap are well documented and communicated within the organization. The organization has a process to monitor AMP implementation. Elements of the AM System are in place.	The organization's strategy and goals are well connected with AM and resource allocation has been defined. The AM policy, objectives and roadmap are well documented and communicated within the organization. Additionally, they are connected with external requirements and updated when necessary. The organization has a process to monitor AMP implementation, with council participation. The AM System is established and its progress is being measured.
People and Leadership *"This competency involves setting up cross-functional teams with clear accountability, and ensuring adequate resourcing and commitment from senior management and elected officials to advance asset management."*	Council is not aware or does not support AM practices, so no human-resources or financial-resources were approved.	People responsible for AM are being appointed, but no AM team or roles and responsibilities are defined yet. Council is still learning about AM benefits. Financial resources were insufficient to develop AM planned actions.	An AM team has been recently established and, as a consequence, not all roles and responsibilities were defined. The AM team does not count with resources from different departments. Council supports AM and resources were sufficient to implement priority improvements to the AM System.	The AM team is mature, has clear roles and responsibilities and counts with resources from different departments. Council champions AM and, consequently, there are sufficient financial resources to support AM planned actions.
Data and Information *"This competency involves using asset data, performance data and financial data to support effective asset management planning and decision-making."*	Regarding data inventory, there is information on some attributes for key assets. Asset data analysis is mostly used for operation and maintenance and no process was established for condition assessment. The assets' levels of service are not stated on the AMP. Financial data is mainly used for compliance with PS 3150 reporting requirements.	Regarding data inventory, there is information on some attributes for all assets. Asset data analysis is performed and helps to determine asset condition and prioritization. Condition assessment helps to improve operational services. The assets' levels of service are not stated on the AMP, but the organization is planning on adding it. Financial data is not only used for compliance with PS 3150 reporting requirements but also to set capital and operational expenditures.	Regarding data inventory, there is information on sufficient attributes for all assets. Asset data analysis is performed and helps to determine current levels of service. Condition assessment provides inventory and criticality update. The assets' levels of service are stated on the AMP according to regulatory requirements. Financial data is used for compliance with PS 3150 reporting requirements; to set capital and operational expenditures; and to determine costs to maintain current levels of service.	Regarding data inventory, there is information on sufficient attributes for all assets linked to its performance . Asset data analysis is performed and helps to determine proposed levels of service. Condition assessment provides investment prioritization and improved decision-making. The assets' levels of service are stated on the AMP according to regulatory and technical requirements. Financial data is used for compliance with PS 3150 reporting requirements; to set capital and operational expenditures; to determine costs to maintain current levels of service; and to identify future needs and funding gaps.
Planning and Decision-making *"This competency involves documenting and standardizing how the organization sets asset management priorities, conducts capital and operations and maintenance (O&M) planning, and decides on budgets."*	The organization has not developed an AMP. There is no tool or process in place to manage assets or prioritize investments. Budgeting and capital investments are based on current needs and there is no process in place to identify funding gaps	The AMP is not taken in consideration in the decision-making process. GIS or other software that aggregates data is the main source of information for asset decisions, and prioritization only addresses short-term needs and varies across the organization. Financial planning for capital investment is usually based on population growth.	The AMP is often used as a source of information for asset management decisions. Prioritization follows asset investment plans and is based on organizational objectives. Short-term financial planning for capital and operational expenditures is based on current levels of service and helps to identify funding gaps.	The AMP is fully integrated with the decision-making processes. Investment prioritization follows asset investment plans and balances the current levels of service with longer-term goals and risks. Long-term financial planning associated with asset lifecycle and levels of service help to identify funding gaps.
Contribution to Asset Management Practice *"This competency involves asset management training, developing staff, sharing knowledge internally and participating in external knowledge sharing."*	As the organization provided no training on asset management, employees' development is informal and self-driven. Asset management knowledge is concentrated in key people. The organization does not attend asset management events.	The organization facilitated in-house asset management meetings and workshops, but employees' development is still triggered by short-term needs. Internal knowledge sharing is being improved through record keeping. The organization attends at least one asset management event per year.	The organization promotes basic asset management awareness training to all employees. The organization is structuring internal asset management knowledge sharing resources. External opportunities for sharing asset management knowledge are embraced, along with attendance at at least one event per year.	Training and guidance are provided based on competence evaluation, as the organization selects and trains internal experts to support the development of organizational capacity. Internal knowledge and information are freely shared throughout the organization, which actively participates in asset management events and shares its experience with peers.

The final readiness level reached by a municipality in a specific competency area corresponds to the lowest score among the questions of that competency. As an example, there are five scorable questions regarding the "data and information" competency area. Their intent is to check FCM's outcomes in this competency area, which concern asset data, performance data and financial data. To be classified in RL 2, a municipality must have achieved all outcomes corresponding to that readiness level. Even in the case where a respondent has selected alternatives corresponding to RL 3 for four out of the five questions and RL 2 for one question, it would still be classified as a RL 2. It is important to mention that skipped questions represented only eight from a total of 837 scorable questions (31 municipalities times 27 scorable questions) and determined a RL 0 for a competency area in only three cases.

Moreover, competency scores are computed to determine how close municipalities are of reaching the next readiness level. The scores represent the points average for each competency area and give an indication of how advanced a municipality is in adopting asset management practices. The minimum score is zero and the maximum is three points, indicating that the municipality is closer to RL 3.

A municipality that has reached RL 1 and has a score of 2.4 is much more advanced in its asset management journey than another that has been classified in RL 1 with a score of 1.1. Consequently, results will consider both the readiness level classification and the scores to establish a baseline for water utilities' asset management practices.

3.3.2.2 Non-scorable Questions

From the remaining 27 questions, 12 collected additional asset management information with respect to Ontario Regulation 588/17, asset management value, previous maturity or readiness assessments, Asset Management Plans, confidence level regarding asset data inventory, tools to manage asset data, and funding gaps.

These questions were strategically placed to allow a glimpse into key elements of effective and advanced asset management, including integration with climate change, organization self-assessment, decision-making based on asset data, accurate data inventory, enhanced asset data

management, and user fees' affordability. Table 3.7 shows the non-scorable questions organization per section.

Table 3.7: Non-scorable questions per section.

Section	Total number of non-scorable questions	Questions' position
Background Questions	3	1, 2, 4
Strategic Vision and Asset Management Plan	6	6, 7, 9, 10, 11, 16
Policy and Governance	0	-
People and Leadership	0	-
Data and Information	2	27, 28
Planning and Decision-making	4	33, 36, 37, 38
Contribution to Asset Management Practice	0	-
Specific Background Questions	7	43, 44, 45, 46, 47, 48, 49
Identification of Target Population	5	50, 51, 52, 53, 54

3.3.3. Benchmark Report

Historically, non-mandatory surveys have a higher response rate when they offer some form of reward to participants (SRC, 2018). The most common rewards are gift certificates and electronic gadgets, therefore implying that the benefit would be personal and not for the organization. With the purpose of providing a reward related to asset management and that would be beneficial to municipalities, benchmarking was chosen.

Benchmarking has been used in the water sector to compare practices in different utilities and encourage the adoption of better processes (Jones, 2014). For this reason, tailored benchmark reports were offered to participant municipalities, comparing the aggregated results of municipalities in the same size category with the readiness level and score of the participant.

These reports were developed after all data was collected and compiled, and sent to all municipalities that have requested it. The benchmark report, presented in Appendix C, is divided in four sections:

(a) **Survey information:** brings relevant information about the readiness assessment methodology, data analysis and respondents' background. This page is the same for all municipalities.

(b) **Benchmark page:** provides a table containing the average readiness level of all participant municipalities in the same size category compared with the individual municipality's readiness level and score, organized by competency. Additionally, a radar chart depicting the readiness levels per competency is presented.

(c) **Readiness level description:** an infographic describing the outcomes for each one of the five competency areas, from RL 0 to RL 3, was added to the report to bring awareness regarding asset management processes and practices and stimulate positive change. This page is the same for all municipalities.

(d) **Municipality survey responses:** the municipality's answers to the 54 survey questions were included for clarity and review. With this information the municipality can identify areas for improvement based on the outcomes described in Item "c".

Chapter 4
Summary of Results

4.1. Overview

A summary of the relevant survey results is presented in this Chapter. A brief overview of survey participants is given in Section 4.2. Sections 4.3 to 4.7 bring the scorable results regarding the five competency areas, namely, policy and governance, people and leadership, data and information, planning and decision-making, and contribution to asset management practice. The questions contained in these five competency areas determined municipalities' asset management readiness levels and scores. Finally, Section 4.8 explores non-scorable questions important aspects related to asset management, as funding gaps and planning for climate change. Appendix D displays the tabulated results for the most significant survey questions.

4.2. Background of Survey Participants

Municipalities from all regions, size categories and tier types have participated in the survey. More specifically, 31 municipalities representing 50.6% of Ontario's total population – 6,803,276 people out of 13,448,494, according to the 2016 Census (Statistics Canada, 2017) – contributed to this study. Considering that the 444 Ontario municipalities operate 665 drinking water systems and 466 wastewater systems (Association of Municipalities Ontario, 2016), the number and diversity of respondents were crucial for survey success. The detailed background of participants is depicted in Figures 4.1, 4.2 and 4.3, showing respectively the number of municipalities by size, region and tier type.

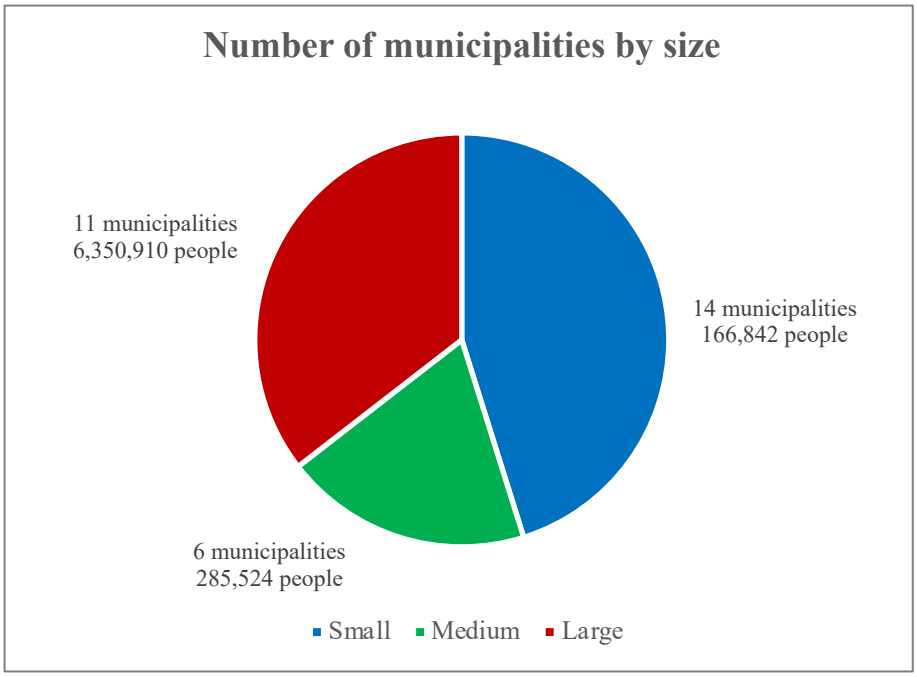

Figure 4.1: Number of municipalities by size.

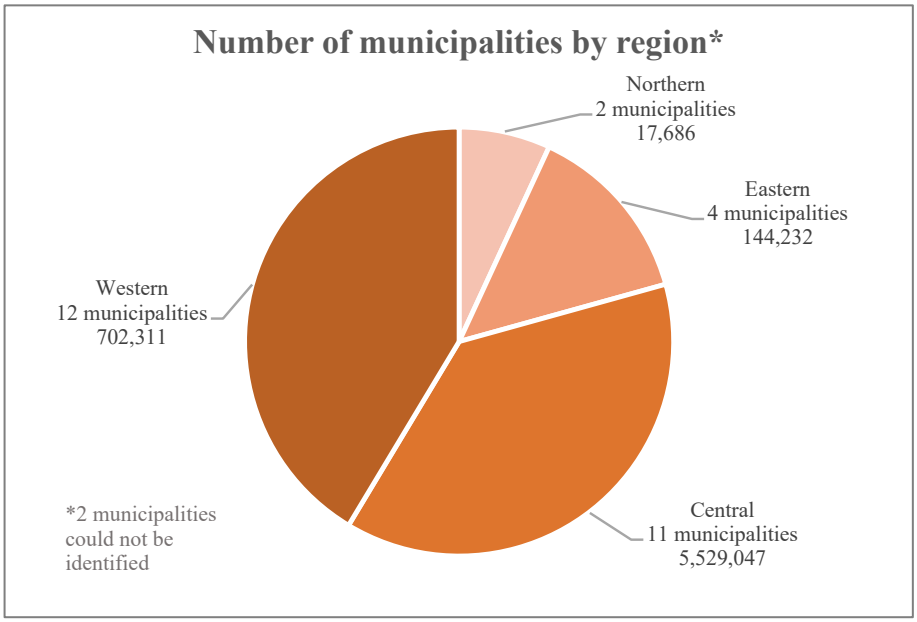

Figure 4.2: Number of municipalities by region.

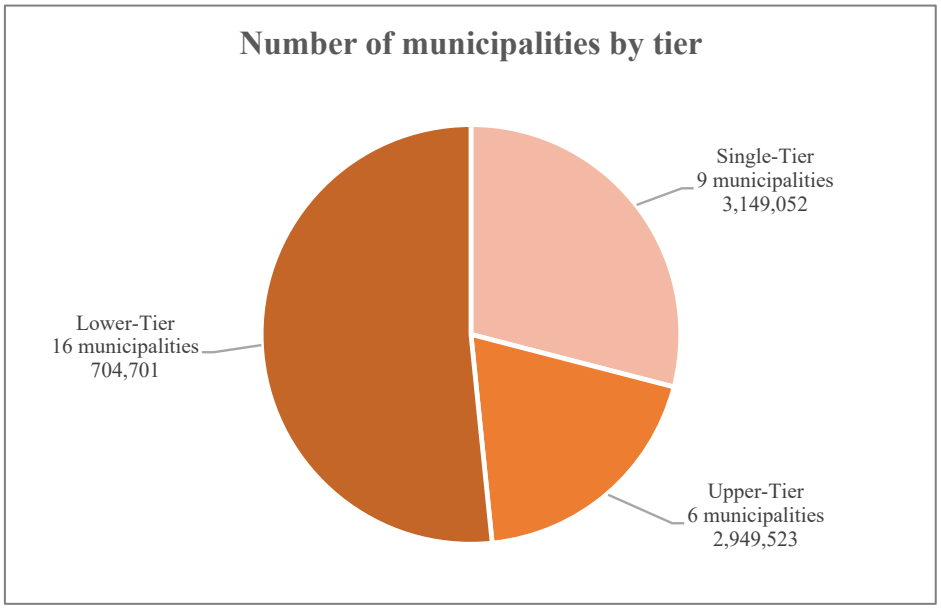

Figure 4.3: Number of municipalities by tier.

4.3. Policy and Governance

According to FCM's Asset Management Readiness Scale, the policy and governance competency "involves putting in place policies and objectives related to asset management, bringing those policies to life through a strategy and roadmap, and then measuring progress and monitoring implementation over time" (Federation of Canadian Municipalities, 2017). In terms of outcomes, it means having a structured AMS, with a policy that outlines the organization's commitments and sets the foundation for asset management objectives, which in turn provide direction and alignment with strategic objectives. In addition, measuring the AMS's performance is key for continual improvement.

The averaged readiness levels and scores of small, medium-sized and large municipalities are presented in Table 4.1. Figure 4.4 displays the distribution of individual readiness levels and scores. It is clear that large municipalities have developed more advanced practices regarding the policy and governance competency, followed by small municipalities. Next, the results by outcomes are described according to municipalities' size.

Table 4.1: Policy and governance averaged readiness level and score.

Municipalities' size	Readines Level	Readiness Score	Standard Deviation*
Small	0.36	1.08	0.70
Medium	0.17	0.97	0.43
Large	1	1.58	1.04

*Refers to Readiness Score

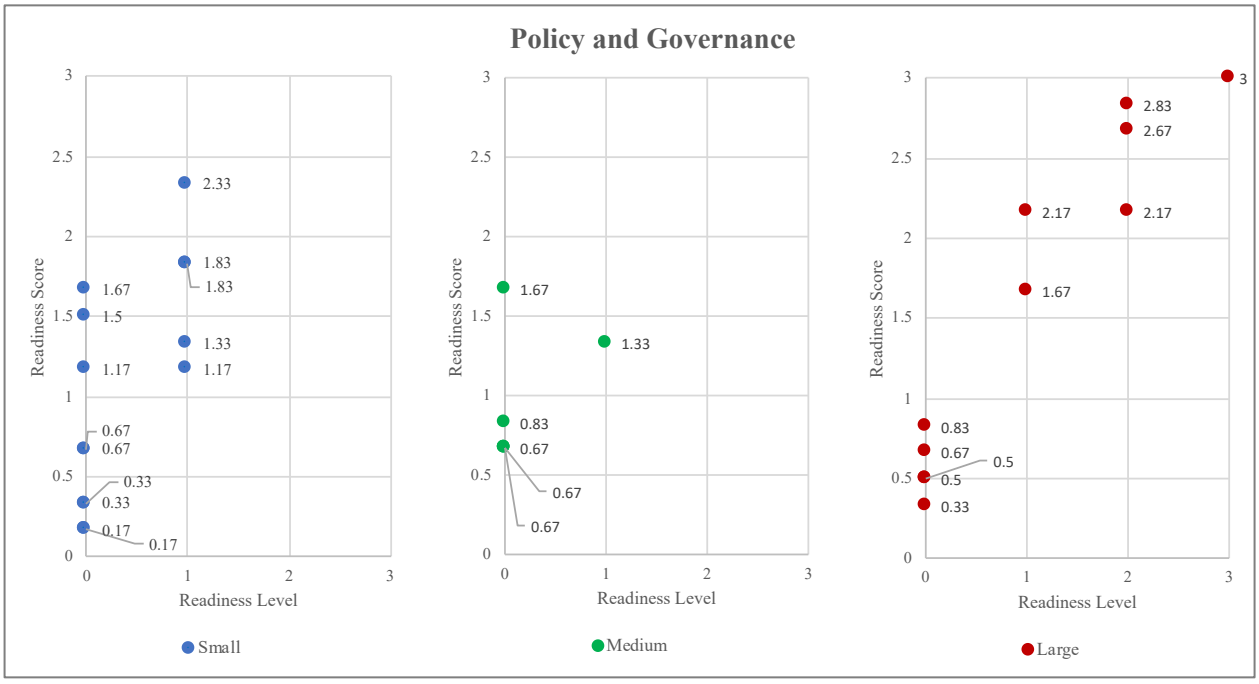

Figure 4.4: Policy and governance distribution of individual readiness levels and scores.

Small municipalities

(a) ***Asset management and the organization's strategic plan (Question 5):*** while 43% of respondents have reported a clear connection between the organization's strategy and asset management, for only 14% of them resource allocation has been defined. For 50% of municipalities, the connection between asset management and the organization's goals is not clear.

(b) ***Asset Management Plan implementation (Question 17):*** though 57% of the total of responding municipalities currently do not have a process to monitor plan implementation, 50% of them are planning to establish one. 21% already have a process to monitor plan implementation. Surprisingly, 22% of municipalities were not sure whether they have a process to monitor plan implementation or not.

(c) ***Asset management objectives (Question 18):*** 22% of participants have not defined any asset management objectives. For 43%, objectives have been defined but are not well documented or communicated. 28% of respondents have well documented and communicated objectives, consistent with the organization's objectives.

(d) ***Asset Management Policy (Question 19):*** 29% of respondents do not have an Asset Management Policy, while for 14% the Policy exists but is not well communicated. 43% of municipalities have a Policy that is well communicated within the organization.

(e) ***Roadmap or the actions to achieve asset management objectives (Question 20):*** 29% of the respondent municipalities have not defined any actions to achieve its asset management objectives. For 22% of participants, actions have been defined but are not well communicated. 28% have reported that actions are well communicated throughout the organization.

(f) ***Asset Management System (Question 21):*** half of the respondents do not have a System in place, but 29% of these respondents are planning to implement one. 29% of municipalities have set up the elements and processes required for an Asset Management System.

Medium-sized municipalities

(a) ***Asset management and the organization's strategic plan (Question 5):*** for 67% of respondents, there is a clear connection between the organization's strategy and asset management, but no defined resource allocation. The connection between asset management and the organization's goals is not clear for 16% of municipalities.

(b) ***Asset Management Plan implementation (Question 17):*** 50% of participants do not have a process to monitor plan implementation but are planning to establish one. 33% already have a process in place.

(c) ***Asset management objectives (Question 18):*** 50% of municipalities do not have defined asset management objectives. For 17%, objectives have been defined but are not well documented or communicated. 33% of municipalities reported well documented and communicated objectives, that are consistent with the organization's objectives.

(d) ***Asset Management Policy (Question 19):*** 33% of the respondent municipalities do not have an Asset Management Policy, while for 50% the Policy is not well communicated. As the rest of municipalities have chosen the "I am not sure" option, none of them reported having a well communicated Policy in place.

(e) ***Roadmap or the actions to achieve asset management objectives (Question 20):*** no actions have been defined for 20% of participants, whereas for 60%, actions have been defined but are not well communicated throughout the organization. Additionally, 20% of participants indicated that the actions are well communicated and support asset management objectives.

(f) ***Asset Management System (Question 21):*** while none of the respondents have an Asset Management System in place, 67% are planning to establish one.

Large municipalities

(a) ***Asset management and the organization's strategic plan (Question 5):*** all municipalities have reported a clear connection between the organization's strategy and asset management; however, for 64% of them, resource allocation has not been defined.

(b) ***Asset Management Plan implementation (Question 17):*** 45% of municipalities have a process in place to monitor Plan implementation, while 55% do not have one. 37% of municipalities that do not monitor Plan implementation are planning to establish a process for that.

(c) ***Asset management objectives (Question 18):*** 64% of participants have defined asset management objectives, but 9% of the total of participants still need to document and better communicate objectives. 18% do not have defined asset management objectives.

(d) ***Asset Management Policy (Question 19):*** 28% of respondent municipalities have no Policy. For 27%, the Asset Management Policy is not well communicated, while for 36% of respondents it is well communicated within the organization.

(e) ***Roadmap or the actions to achieve asset management objectives (Question 20):*** while 27% of municipalities have not yet defined the actions, for 55% of them actions have been defined and are well communicated within the organization.

(f) ***Asset Management System (Question 21):*** only 18% of respondents have an established System and are measuring and monitoring its progress over time, while 28% of municipalities have set up the required elements and processes for an Asset Management System. 36% have not established a System yet, but half of these participants are planning to establish one.

4.4. People and Leadership

FCM's Asset Management Readiness Scale defines the people and leadership competency as "setting up cross-functional teams with clear accountability and ensuring adequate resourcing and commitment from senior management and elected officials to advance asset management" (Federation of Canadian Municipalities, 2017). The outcomes of this competency include establishing a cross-functional (i.e. comprising human resources from different departments) and capable asset management team, with clear roles and responsibilities, as well as having council's support and commitment, to guarantee sufficient resources for asset management.

Table 4.2 shows the averaged readiness levels and scores for small, medium and large municipalities. The distribution of individual readiness levels and scores is shown in Figure 4.5. Scores for this competency are somewhat leveled among municipalities, with large municipalities presenting slightly higher values. Following that, the results by outcomes are described according to municipalities' size.

Table 4.2: People and leadership averaged readiness level and score.

Municipalities' size	Readines Level	Readiness Score	Standard Deviation*
Small	0.79	1.59	0.80
Medium	0.5	1.53	0.73
Large	1.18	1.76	1.05

*Refers to Readiness Score

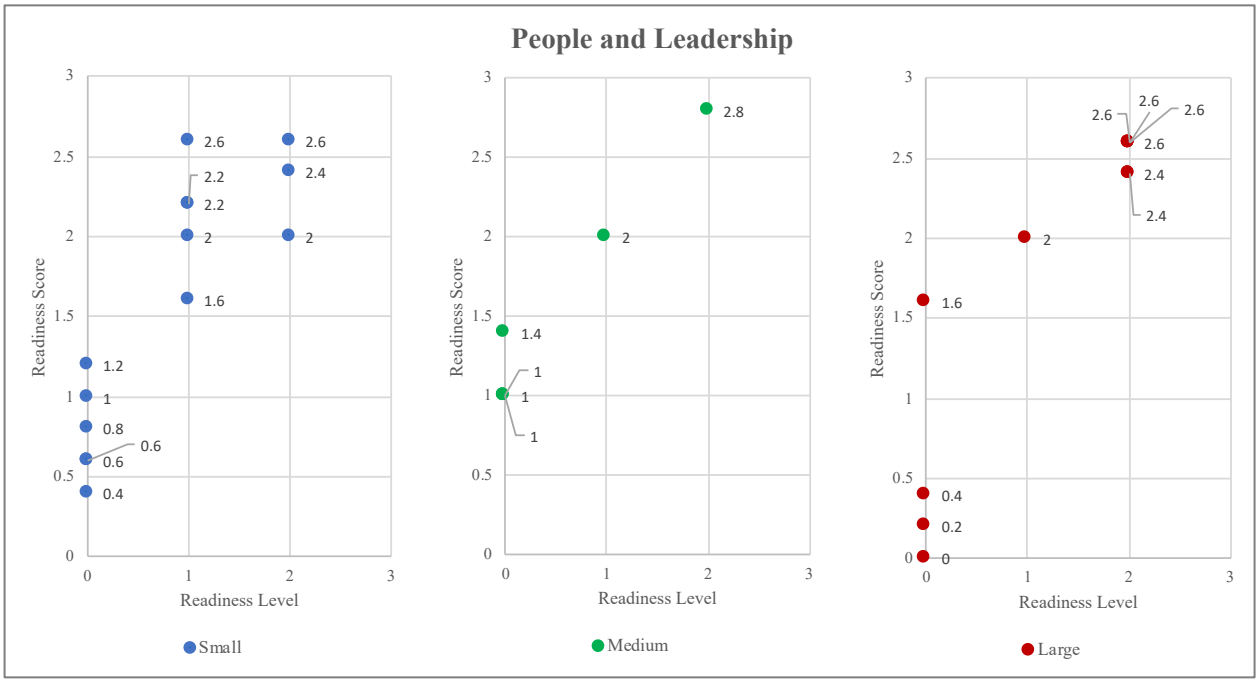

Figure 4.5: People and leadership distribution of individual readiness levels and scores.

Small municipalities

(a) ***Cross-functional asset management team (Questions 3 and 23):*** municipalities indicated that the asset management team has been in place for more than two years (43%) and less than two years (22%), while 28% do not have one. For 43% of respondents, teams are cross-functional.

(b) ***Leadership roles and responsibilities (Question 22):*** 29% of municipalities reported having people dedicated to asset management, but roles and

responsibilities are not defined. There is an accountable asset management team, but not all roles and responsibilities are defined for 43% of respondents. Only 7% reported having a team with clearly defined roles and responsibilities.

(c) ***Council's support and commitment (Question 24):*** for 57% of participants, council demonstrates buy-in and supports asset management. Council supports asset management practices but is not aware of its requirements was the chosen option for 29% of respondents.

(d) ***Financial resources for asset management planned actions (Question 25):*** 29% of respondents reported that there were sufficient financial resources to support last year's asset management planned actions, whereas 28% indicated that the resources were sufficient, but the planned actions only comprised priority improvements to the asset management system. 29% of municipalities have chosen the "I am not sure" option.

Medium-sized municipalities

(a) ***Cross-functional asset management team (Questions 3 and 23):*** 50% of municipalities do not have an asset management team, but 33% of them are planning to establish one. 50% of respondents have asset management teams. For 50% of the organizations, teams are not cross-functional, while for 33% they are.

(b) ***Leadership roles and responsibilities (Question 22):*** 50% of the respondent municipalities reported having no defined leadership roles and responsibilities. 33% indicated that there are people responsible for asset management, but roles and responsibilities have not been defined. For 17% there is an accountable asset management team, but not all roles and responsibilities have been defined.

(c) ***Council's support and commitment (Question 24):*** for 33% of participants, council supports asset management practices but is not aware of its requirements, while 33% indicated that council demonstrates buy-in and support for asset management. 17% of municipalities reported that council champions asset management as a core business function.

(d) ***Financial resources for asset management planned actions (Question 25):*** there were sufficient financial resources last year to support the asset management planned actions for 33% of the respondent municipalities. For 17% of respondents, there were sufficient financial resources, but the planned actions only comprised priority improvements to the AMS. Conversely, the allocated financial resources were not sufficient for 50% of respondents.

Large municipalities

(a) ***Cross-functional asset management team (Questions 3 and 23):*** while 27% of municipalities do not have an asset management team, the team has been in place for more than two years in 55% of the cases, and less than 2 years in 18%. Cross-functional teams were reported by 64% of respondents.

(b) ***Leadership roles and responsibilities (Question 22):*** 46% of participants reported that there is an accountable asset management team, but not all roles and responsibilities are defined. For 27%, there is an asset management team and their roles and responsibilities are clearly defined.

(c) ***Council's support and commitment (Question 24):*** for 64% of respondent municipalities, council demonstrates buy-in and supports asset management.

(d) ***Financial resources for asset management planned actions (Question 25):*** 37% of participants were not sure about this question, as in large municipalities budget information is usually concentrated in key people. For 27% of participants, last year's resources were sufficient, but the planned actions only comprised priority improvements to the Asset Management System. Similarly, 27% indicated that there were sufficient financial resources to support the planned actions.

4.5. Data and Information

The data and information competency involves "using asset data, performance data and financial information to support effective asset management planning and decision-making", as per FCM's Asset Management Readiness Scale definition (Federation of Canadian Municipalities,

2017). The outcomes for this competency include having a complete data inventory, preferably linked with asset performance information, and accurate condition assessment data. Additionally, levels of service and financial information help to identify future needs and funding gaps.

The averaged readiness levels and scores of small, medium and large municipalities are presented in Table 4.3, while Figure 4.6 illustrates the distribution of individual readiness levels and scores. Once more, size matters, and large municipalities have demonstrated more advanced practices concerning data and information. Next, the results by outcomes are described according to municipalities' size.

Table 4.3: Data and information averaged readiness level and score.

Municipalities' size	Readines Level	Readiness Score	Standard Deviation*
Small	0.43	1.39	0.80
Medium	0.33	1.47	0.71
Large	0.82	1.91	0.48

*Refers to Readiness Score

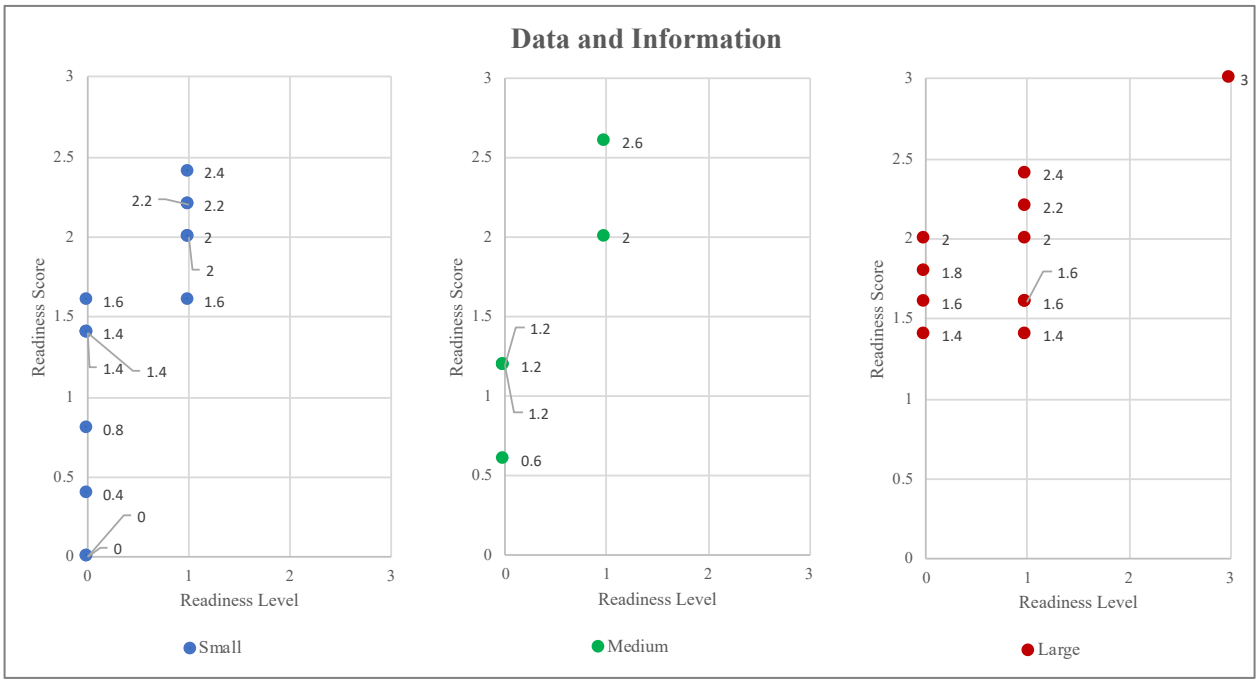

Figure 4.6: Data and information distribution of individual readiness levels and scores.

Small municipalities

(a) ***Asset's Levels of Service (Question 15):*** the AMP specifies asset's Levels of Service (LoS) for 54% of the respondent municipalities. LoS are not specified in the Plan for 31% of respondents, but 23% of them are planning to add LoS in their AMPs.

(b) ***Asset inventory data (Question 26):*** the municipalities work mostly with basic (29%) and adequate (43%) asset inventory data. Only 14% of respondents have reported working with comprehensive data information for their asset inventories.

(c) ***Asset condition assessment practices (Question 29):*** for 65% of respondents, the main benefit of current asset condition assessment practices is asset investment prioritization and improved decision-making. 14% of municipalities have not established a process for condition assessment and other 14% have chosen inventory and criticality update as the main benefit of the current condition assessment practices.

(d) ***Asset data analysis (Question 30):*** data analysis helps to determine asset condition and prioritization for 54% of participants. 31% reported that the organization works with limited asset data information and analysis, mostly used for operation and maintenance.

(e) ***Financial information (Question 31):*** financial information is mainly used to set capital and operational expenditures, followed by PS 3150 reporting requirements. This was a "mark all that apply" question.

Medium-sized municipalities

(a) ***Asset's Levels of Service (Question 15):*** 50% of respondents are planning to add LoS to their AMPs, whereas for 50%, LoS are already specified in the Plan.

(b) ***Asset inventory data (Question 26):*** the municipalities work with basic (67%), adequate (16%), and comprehensive (17%) asset data information for inventory.

(c) ***Asset condition assessment practices (Question 29):*** 16% of participants have not established a process for condition assessment. The main benefit of current asset condition assessment practices is asset investment prioritization and improved

decision-making, according to 67% of participants. For 17% of municipalities, improved operation services would be the main benefit.

(d) ***Asset data analysis (Question 30):*** 50% of municipalities work with limited asset data information and analysis, mostly used for operation and maintenance. The other 50% indicated that data analysis helps to determine asset condition and prioritization.

(e) ***Financial information (Question 31):*** financial information is mainly used to set capital and operational expenditures, followed by PS 3150 reporting requirements.

Large municipalities

(a) ***Assets' Levels of Service (Question 15):*** 73% of respondents reported that assets' LoS are specified in their AMPs. Assets' LoS are not specified for 18% of participants.

(b) ***Asset inventory data (Question 26):*** the municipalities work with basic (46%), adequate (36%) and comprehensive (18%) asset inventory data.

(c) ***Asset condition assessment practices (Question 29):*** asset investment prioritization and improved decision-making is the main benefit of current asset condition assessment practices according to 64% of the respondent municipalities. Improved operation services (18%) and inventory and criticality update (18%) were reported by the remaining respondents.

(d) ***Asset data analysis (Question 30):*** for 64% of participants, data analysis helps to determine asset condition and prioritization, whereas for 27%, data analysis combines different data inputs to determine proposed LoS. 9% of municipalities work with limited asset data information and analysis and use it to inform operations and maintenance.

(e) ***Financial information (Question 31):*** financial information is well used to inform a variety of processes, equally including capital and operational expenditures and PS 3150 reporting requirements, followed by the costs to maintain current LoS and future needs and funding gaps identification.

4.6. Planning and Decision-making

The planning and decision-making competency encompasses "documenting and standardizing how the organization sets asset management priorities, conducts capital and operations and maintenance (O&M) planning, and decides on budgets", according to FCM's Asset Management Readiness Scale (Federation of Canadian Municipalities, 2017). Outcomes to this competency require having an AMP that is used to inform decisions, determining a process to prioritize investments, and being able to identify funding gaps, through long-term financial planning.

The averaged readiness levels and scores of small, medium and large municipalities are presented in Table 4.4. The distribution of individual readiness levels and scores is shown in Figure 4.7. Medium-sized municipalities seem to be struggling with planning and decision-making, falling behind of small municipalities. Despite of the high score, large municipalities still need to implement processes and practices to advance their readiness levels. Next, the results by outcomes are described according to municipalities' size.

Table 4.4: Planning and decision-making averaged readiness level and score.

Municipalities' size	Readines Level	Readiness Score	Standard Deviation*
Small	0.43	1.55	0.69
Medium	0.17	1.43	0.52
Large	0.55	1.97	0.58

*Refers to Readiness Score

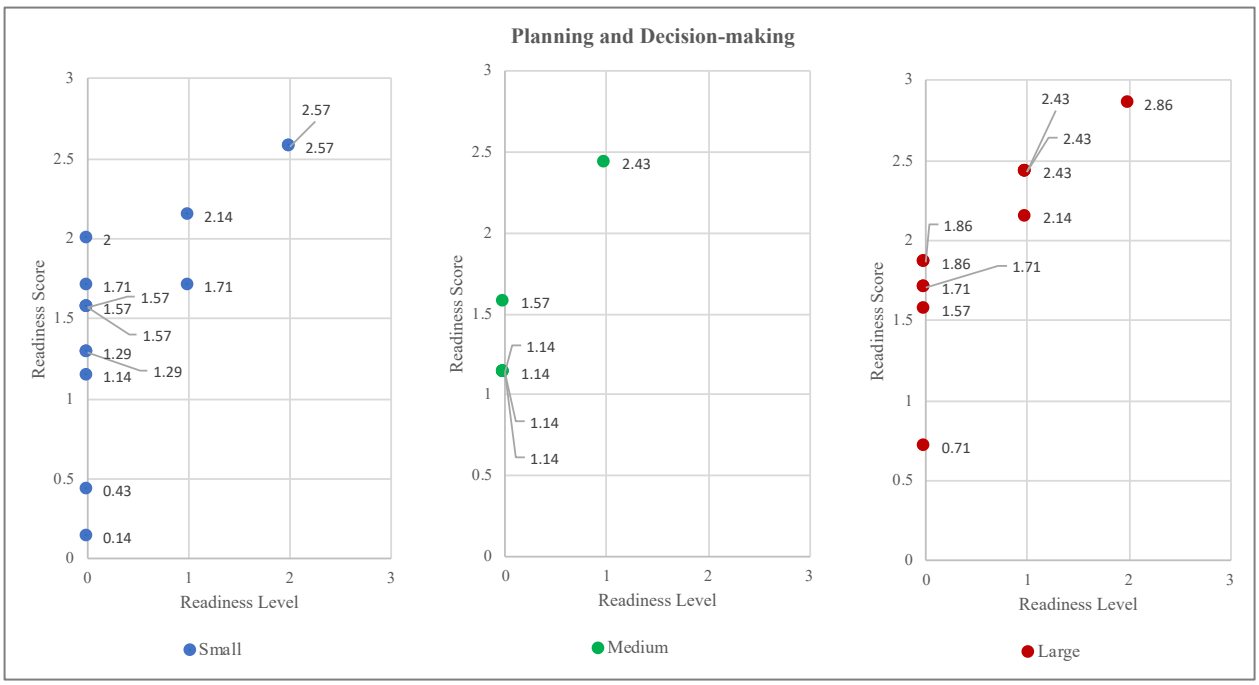

Figure 4.7: Planning and decision-making distribution of individual readiness levels and scores.

Small municipalities

(a) ***Asset Management Plan (Questions 8 and 14):*** 22% of municipalities do not take the AMP in consideration when making asset decisions, 50% reported sometimes basing decisions on the Plan, and 14% have the Plan fully integrated into the decision-making process. Another 14% of municipalities informed not having an AMP, but that they are planning to develop one. The AMP timeframe is of 20 years or more for 57% of municipalities.

(b) ***Source of information for planning and decision-making (Question 32):*** 21% of respondents reported that there is no tool or source of information in place to manage assets. The main source of information is GIS or other software that aggregates data for 43% of respondents and the AMP for 36% of respondents.

(c) ***Investment prioritization decisions (Question 34):*** only 36% of participants indicated that investment prioritization decisions are based on the asset investment

plan. For 43% of municipalities, the prioritization of investment decisions still relies on staff experience, council and management input and available information.

(d) ***Identification of funding gaps (Question 35):*** 28% of the respondents do not have a process in place to identify funding gaps. 65% have a process, from which: short-term financial planning is based on current LoS (36%) and long-term financial planning is associated with asset lifecycle and LoS (29%).

Medium-sized municipalities

(a) ***Asset Management Plan (Questions 8 and 14):*** 50% of municipalities do not consider the AMP in the decision-making process, 17% sometimes base asset decisions on it, while 17% have the plan fully integrated in the decision-making process. 16% of municipalities informed not having an AMP, but that they are planning to develop one. The Plan's timeframe is of 20 years or more for only 33% of municipalities.

(b) ***Source of information for planning and decision-making (Question 32):*** 16% of the respondent municipalities reported that there is no tool or source of information in place to manage assets. The main source of information is GIS or other software that aggregates data for 67% of respondents and the AMP for only 17% of respondents.

(c) ***Investment prioritization decisions (Question 34):*** For 83% of participants, prioritization usually addresses short-term needs, with teams setting priorities independently. Only 17% of participants indicate that decisions are based on the asset investment plan.

(d) ***Identification of funding gaps (Question 35):*** 33% of respondents do not have a process in place to identify funding gaps. 50% have a process, from which: short-term financial planning is based on current LoS (33%) and long-term financial planning is associated with asset lifecycle and LoS (17%).

Large municipalities

(a) ***Asset Management Plan (Questions 8 and 14):*** 27% of municipalities do not consider the AMP in the decision-making process, whereas 27% sometimes base asset related decisions on the Plan. For 37% of respondents, the Plan is fully integrated in the decision-making process. The AMP timeframe is of 20 years or more for 55% of municipalities.

(b) ***Source of information for planning and decision-making (Question 32):*** the main asset management source of information is GIS or other software that aggregates data for 46% of respondents and the AMP for 45% of respondents.

(c) ***Investment prioritization decisions (Question 34):*** prioritization follows asset investment plans for 55% of municipalities and usually balances the current LoS with longer-term goals and risks. 18% of prioritization decisions address short-term needs, with teams setting priorities independently. For 18% of respondents, priority evaluation is based on experience, council and management input, and available information.

(d) ***Identification of funding gaps (Question 35):*** 9% of the respondents do not have a process to identify funding gaps. 73% have a process, from which: financial planning for capital investment is based on population growth (9%), short-term financial planning is based on current LoS (27%) and long-term financial planning is associated with asset lifecycle and LoS (37%).

4.7. Contribution to Asset Management Practice

FCM's Asset Management Readiness Scale states that the contribution to asset management practice competency includes "asset management training, developing staff, sharing knowledge internally and participating in external knowledge sharing" (Federation of Canadian Municipalities, 2017). Outcomes for this competency include providing training based on competence evaluation, having information flowing freely where it is needed in the organization, and sharing experiences with peers in asset management events.

The averaged readiness levels and scores of small, medium and large municipalities are presented in Table 4.5. Figure 4.8 displays the distribution of individual readiness levels and scores for the contribution to asset management practice competency. Next, the results by outcomes are described according to municipalities' size. Once again, large municipalities appear to have slightly better values than small municipalities, with medium-sized municipalities falling behind.

Table 4.5: Contribution to asset management practice averaged readiness level and score.

Municipalities' size	Readines Level	Readiness Score	Standard Deviation*
Small	0.46	1	0.79
Medium	0.33	0.75	0.63
Large	0.55	1.52	0.90

*Refers to Readiness Score

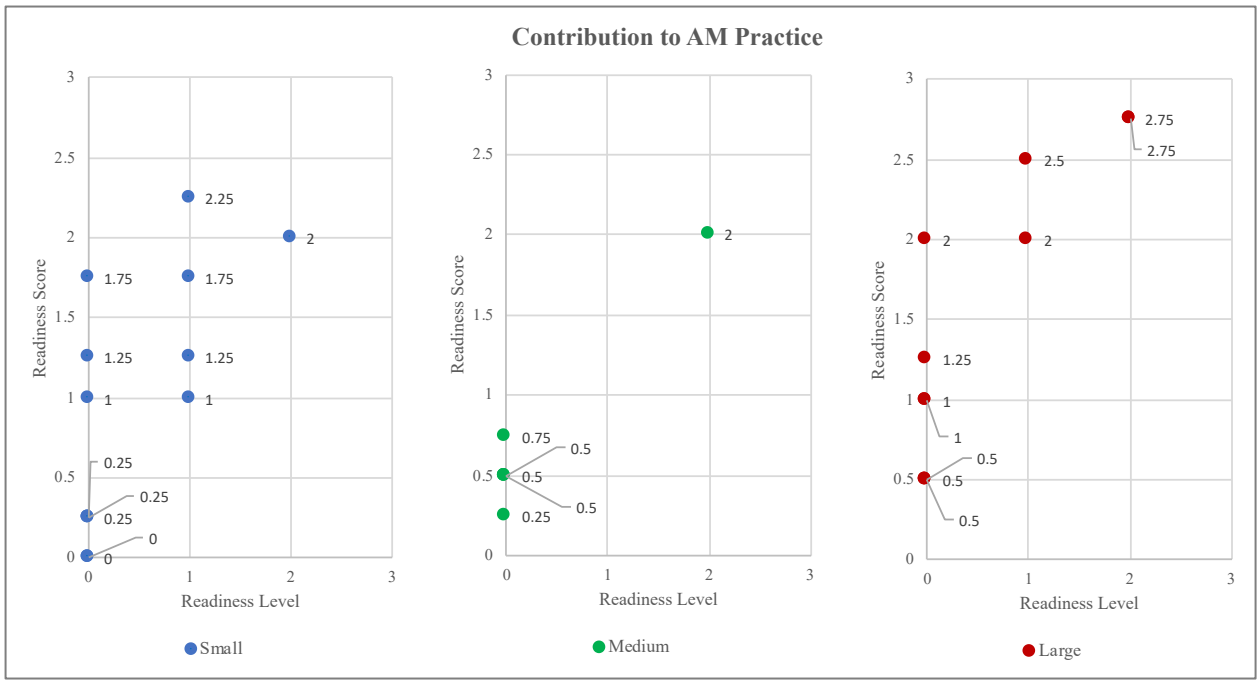

Figure 4.8: Contribution to asset management practice distribution of individual readiness levels and scores.

Small municipalities

(a) ***Employees' asset management development (Question 39):*** the employees' development approach is informal and largely driven by the initiative of team members for 31% of municipalities, while development requirements are based on short-term needs in another 31% of the cases. Only 15% of respondents promote basic awareness training to all employees, and other 15% select and train internal experts to support the development of organizational capacity.

(b) ***Asset management training, guidance and competence evaluation (Question 40):*** 33% of municipalities had a "hit the ground running approach" towards asset management training and guidance, while 33% offered guidance through in-house asset management meetings or workshops. For 17% of respondents, training was provided by hiring specialized third parties or by sending human resources to external training sessions.

(c) ***Internal asset management knowledge sharing (Question 41):*** 23% of respondents indicated that they are mitigating the risk of losing information through improved record keeping. 31% are structuring asset management knowledge sharing resources, whereas 15% report that internal knowledge sharing is not encouraged, and asset management information is concentrated in key people.

(d) ***External asset management knowledge sharing (Question 42):*** 47% of the respondent municipalities attend at least one asset management event per year. 23% also share their experience with peers, in addition to actively participating in asset management events. Only 15% of respondents do not attend asset management events.

Medium-sized municipalities

(a) ***Employees' asset management development (Question 39):*** for 50% of municipalities, development approach is informal and largely driven by the initiative of team members. Development requirements are based on short-term needs for 33% of municipalities. Only 17% of respondents promote basic awareness training to all employees.

(b) ***Asset management training, guidance and competence evaluation (Question 40):*** a "hit the ground running approach" approach was reported by 67% of respondents, while 33% indicated that the organization provided training by hiring specialized third parties or by sending human resources to external training sessions.

(c) ***Internal asset management knowledge sharing (Question 41):*** for 33% of participants, knowledge and information are concentrated in key people, whereas 50% reported that the organization is mitigating the risk of losing information through improved record keeping. Only 17% of municipalities indicated that they are structuring knowledge sharing resources.

(d) ***External asset management knowledge sharing (Question 42):*** 67% of the respondent municipalities attend at least one asset management event per year and only 16% of respondents do not attend asset management events.

Large municipalities

(a) ***Employees' asset management development (Question 39):*** 55% of participants indicated that internal experts are selected and trained to support the development of organizational capacity. Only in 9% of the cases development approach is informal and driven by the initiative of team members. 18% of municipalities promote basic awareness training to all employees, whereas for 18%, development requirements are based on short-term needs.

(b) ***Asset management training, guidance and competence evaluation (Question 40):*** a "hit the ground running approach" was reported by impressive 46% of respondents. The other approaches were providing guidance through in-house meetings or workshops (9%), providing training by hiring specialized third parties or sending human resources to external training sessions (18%), and evaluating the competences needed and providing training and guidance based on them (9%).

(c) ***Internal asset management knowledge sharing (Question 41):*** knowledge and information are concentrated in key people for 18% of municipalities and are freely shared for 36% of municipalities. 37% indicated that the organization is mitigating

the risk of losing information through improved record keeping and only 9% reported that knowledge sharing resources are being structured.

(d) ***External asset management knowledge sharing (Question 42):*** 55% of respondents attend at least one event per year, whereas 27% actively participate in asset management events and share their experiences with peers.

4.8. Additional Asset Management Information from Non-scorable Questions

The information presented in this section allows for a deeper look into other aspects related to asset management. Eight non-scorable questions were selected based on their relevance to the discipline and to the future of asset management processes and practices, as they provide a glimpse into asset data information, planning with climate change in mind, funding gaps and their consequences, organizational readiness assessments, and asset management perceived value.

Asset data information is key for effective asset management; hence, the asset inventory is the foundation over which other types of information will be built upon, i.e. condition assessment, performance data and financial information. Question 27 measured the confidence level of asset data inventory for water and wastewater pipelines. Figure 4.9 shows that 29% of municipalities have very high confidence level regarding their water pipelines inventory, followed by medium confidence level for 26% of municipalities. It is important to note that 19% of respondents have not indicated the confidence level for their water pipelines. Comparatively, the confidence level regarding asset data inventory of wastewater pipelines is significantly lower, indicating high (32%), medium (29%) and very high (19%) levels.

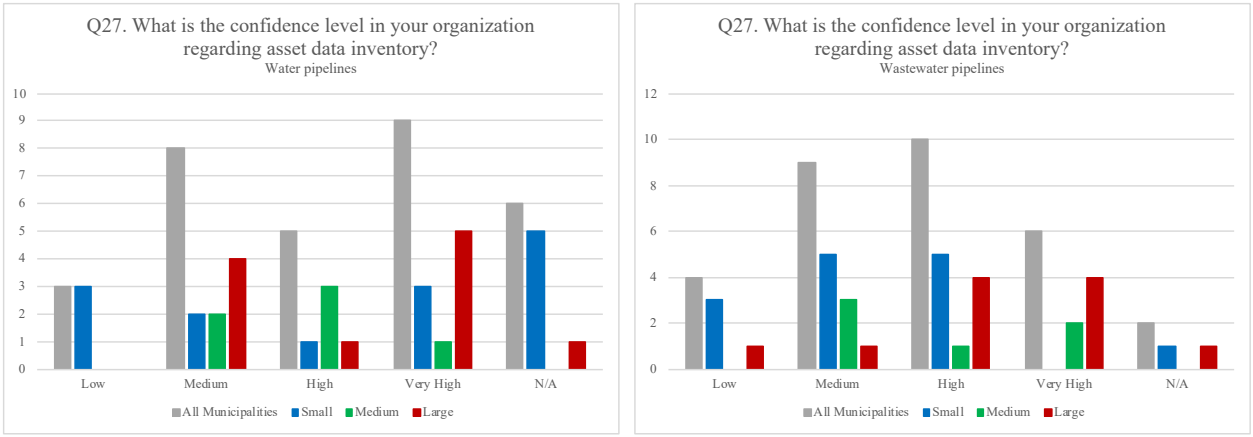

Figure 4.9: Confidence level of asset data inventory for water pipelines (left) and wastewater pipelines (right).

Geographic Information System (GIS) mapping and Microsoft Excel are the most common tools employed to manage asset data, according to Question 28. As shown in Figure 4.10, these tools are used by 84% and 68% of respondents, respectively. In third place is Cityworks, reported by 23% of municipalities.

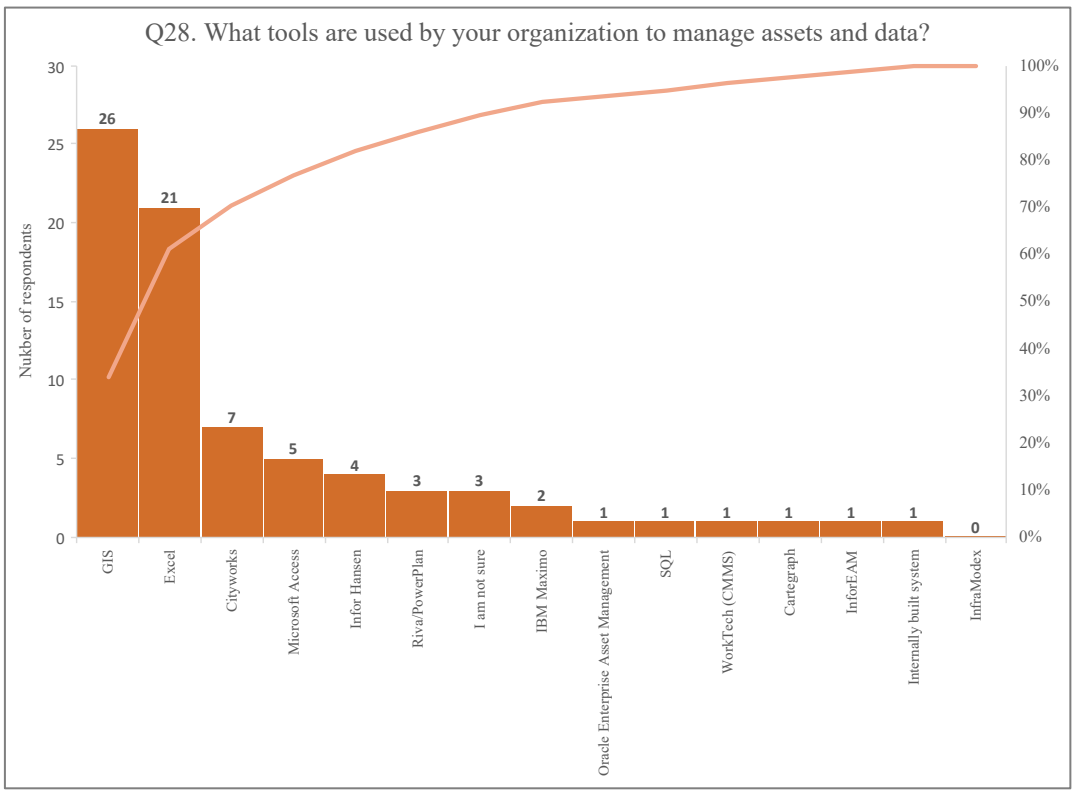

Figure 4.10: Tools used by municipalities to manage asset data.

Managing assets to be resilient to climate change impacts is of the utmost importance to sustain quality of life and safety for communities. Nevertheless, when Question 16 investigated what climate change aspects are considered in asset management planning, staggering 40% of municipalities informed that climate change was not considered in this type of planning. Risk and disaster planning aspects connected to climate change are taken into account for 20% of municipalities, whereas 17% are not sure about the topic. For an additional 17%, climate change is considered in the asset management Policy, but it is not clear how to put that in practice. Figure 4.11 illustrates the climate change aspects considered in asset management planning.

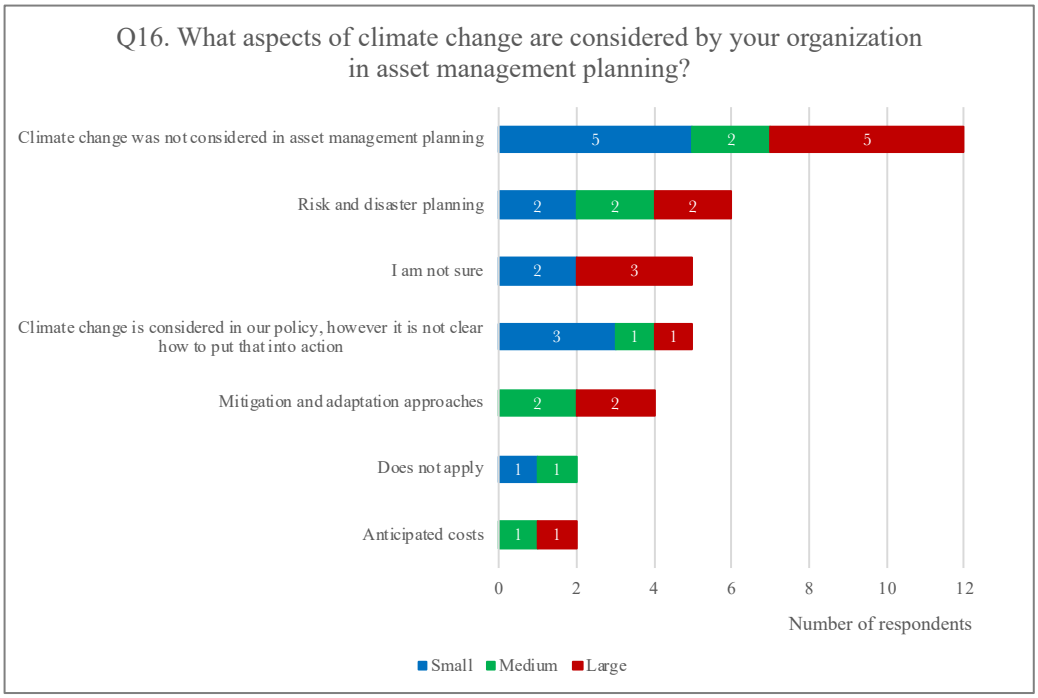

Figure 4.11: Climate change aspects considered in asset management planning.

Funding gaps represent the difference between the financial amount available and what is needed for funding assets' lifecycle activities and capital investments, now and in the future. Question 36 asked municipalities to inform on identified funding gaps for water and wastewater assets. Since about one-third of small and medium municipalities and 9% of large municipalities do not have a process in place to identify funding gaps, it was already expected that several respondents would choose the "Not sure" option.

Nevertheless, only 7% of small, 17% of medium and 9% of large municipalities reported having no funding gap for water assets. For 21%, 33% and 18% of the municipalities, respectively, a funding gap of up to 20% has been identified. The funding gap is 20% or greater for 28% of small, 17% of medium and 27% of large municipalities. This information is given in Figure 4.12.

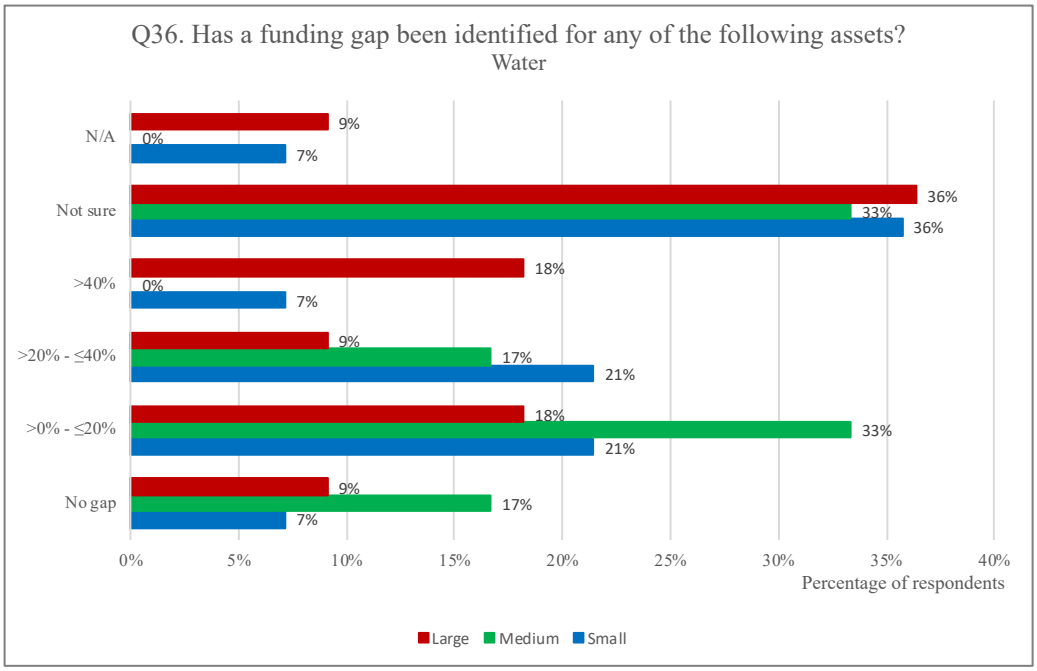

Figure 4.12: Funding gap for water assets.

Similarly, 7% of small, 17% of medium and 18% of large municipalities reported having no funding gap for wastewater assets. In addition, 29% of small and 18% of large municipalities seem to have a funding gap of up to 20%. Funding gaps over 20% were reported by 21% of small, 50% of medium and 27% of large municipalities. This information is presented in Figure 4.13.

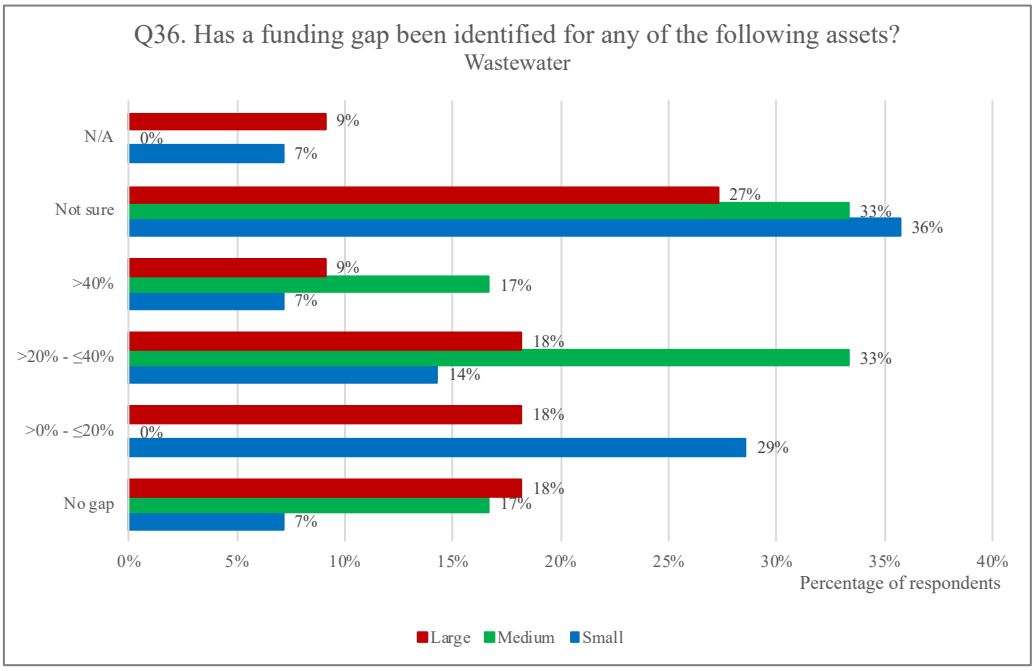

Figure 4.13: Funding gap for wastewater assets.

After a funding gap has been identified, actions to reduce it are needed. Municipalities plan to cover the funding gaps mainly by rising user fees, according to 44% of respondents. Government grants and funding are the chosen option for 13% of municipalities, as displayed in Figure 4.14. Some respondents used the comment section in Question 37 to indicate that a mix of the available options would be the preferred alternative and that debt funding would also be an option. Question 38 inquired about municipalities' plans on increasing user fees in the next 10 years. As depicted in Figure 4.15, only 6% of respondents are not planning to increase fees in the next 10 years, whereas 10% indicated that fees increase will be based on the inflation rate. In contrast, 52% of municipalities forecast increasing the fees up to 20%, while for 9% fees are going to be readjusted by more than 20%.

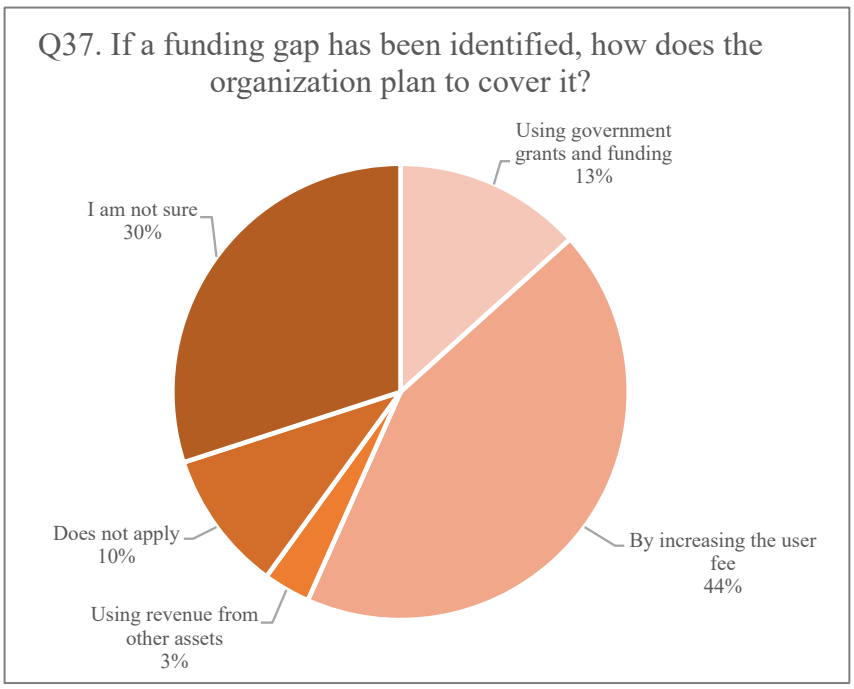

Figure 4.14: Plan to cover funding gap.

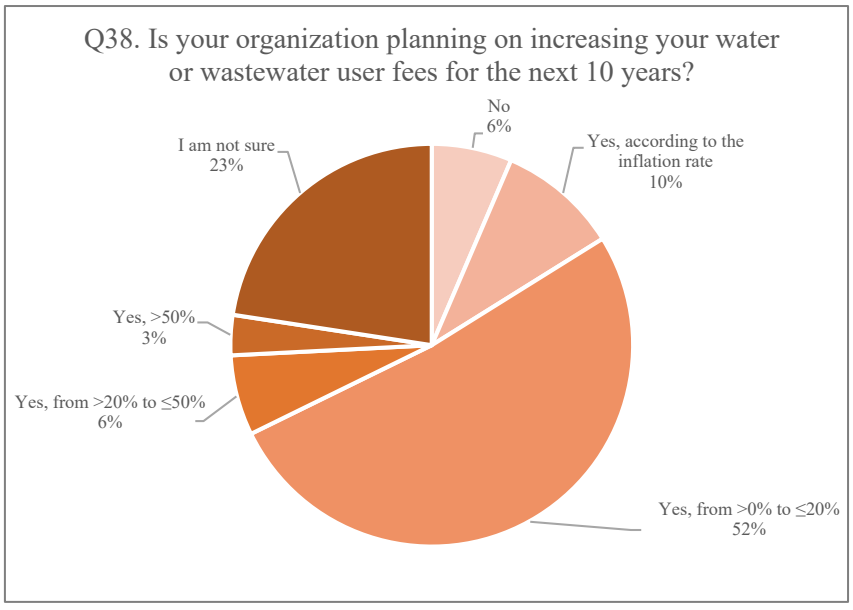

Figure 4.15: User fees increase in the next 10 years.

Asset management readiness assessment is a great tool to help municipalities identifying aspects they want to improve on their systems and to define the necessary actions for it. Question 7 asked municipalities whether they had ever completed a readiness assessment, with results shown in Figure 4.16. Forty-two percent of participants completed a readiness assessment by using an alternative framework (10%), the Federation of Canadian Municipalities' framework (13%), an ISO 55000 based framework (16%), or another industry-based framework (3%). Only 6% out of the 29% of the municipalities that indicated not having completed a readiness assessment are planning to perform one.

Figure 4.16: Percentage of municipalities that have completed a readiness assessment.

Municipalities certainly recognize the value of infrastructure asset management, as represented in Figure 4.17. Question 6 is a "mark all that apply" type, where 81% of respondents indicated that asset management helps with decision-making. Seventy one percent of municipalities have reported that asset management "allows us to get government funding", as expected. Organizational sustainability and risk management were selected by 68% of

respondents. The value added by asset management regarding climate change was the least selected benefit, as understood by 39% of municipalities.

Figure 4.17: Perceived asset management value.

Chapter 5
Discussion

5.1. Overview

Chapter 5 examines the results presented in the previous chapter and compares them with data from other studies, whenever possible. It also analyses results with a holistic approach, considering the discipline's big picture. Section 5.2 contemplates sample background representativeness. Sections 5.3 to 5.7 discuss the results from each one of the five competency areas and the actions and processes that must be implemented if municipalities are to advance to the next readiness level. Inputs from the survey related to the Ontario Regulation 588/17 are reviewed in Section 5.8. Finally, funding gap information is explored in Section 5.9.

5.2. Sample Background

Although the "Water and Wastewater Asset Management Readiness Assessment" survey has included respondents from all Ontario regions, sizes and tier types, the proportion of respondents did not correspond with that of the Province's percentages. Large municipalities were overrepresented, probably because they have greater staff capacity and are usually more involved with asset management. Nevertheless, considering how difficult it is to get municipal water utilities to answer such a long questionnaire, and the number and diversity of the respondent municipalities, this survey was certainly successful.

Table 5.1 brings a comparison of relevant survey studies in Canada and the US. As can be noted, this survey had a high response rate, even with a much smaller advisory committee and team. The number of respondents is in line with that of other Canadian surveys, and the equivalent Ontario population represents just over 50% of the Province's population. All in all, given the scarcity of information regarding asset management practices in municipal water utilities, the sample background is representative and significant for the survey's purpose.

Table 5.1: Comparison of asset management relevant studies in Canada and the US.

Studies / Surveys	Organizations	Number of ON Municipalities (respondents)	Equivalent population	% in relation to ON total population	Survey team / Advisory committee (# of people)	Survey response rate
Establishing the Level of Progress in Utility Asset Management 2015	AWWA	4 (ON) 545 (total)	N/A	N/A	7	1.8%
Canadian Infrastructure Report Card 2016	FCM, CCA, CPWA, CSCE	36	9,436,000	70.2%	27	10.0%
Leveraging Asset Management Data for Improved Water Infrastructure Planning 2018	PSD, CWN, CWWA	32	N/A	N/A	20	N/A
The State of Ontario's Water and Wastewater Infrastructure 2018	OSWCA	30	3,987,430	29.6%	N/A	N/A
Water and Wastewater Asset Management Readiness Survey 2019	**CATT, UW, OWC**	**31**	**6,803,276**	**50.6%**	**3**	**19.6%**

5.3. Policy and Governance

In general, small and medium municipalities have a low readiness level (RL) for policy and governance, very close to zero. However, their scores are close to or surpassing one, indicating that most of their practices align with RL 1. Large municipalities, on the other hand, have reached RL 1 and have averaged scores of 1.58, which demonstrates progress in their practices. Nevertheless, there is still much work to be done.

As the policy and governance competency encompasses Asset Management Systems (AMSs), it requires a structured framework, with strategy, objectives, policy and monitoring processes. For that reason, it was challenging to find other studies with this same approach to contrast results.

Question 5 asked about asset management being part of the organization's strategy. For 67% of medium and 64% of large municipalities there is a clear connection between the organizational strategy and goals with asset management, but resource allocation has not been defined, while for 50% of small municipalities, the connection is not clear. The size of municipalities seems to have great influence on the AMS structure. Question 19, concerning Asset Management Policy, is discussed in Section 5.8.

Fifty percent of medium-sized municipalities have not defined asset management objectives, whereas 43% of small municipalities have defined objectives that are not well documented or communicated, according to Question 18. This might indicate a lack of alignment

between organizational and asset management objectives, risking hindering the AMS. In contrast, 55% of large municipalities have defined asset management objectives that are well documented, communicated and consistent with organizational objectives, suggesting greater System alignment.

Monitoring the AMP implementation is crucial to guarantee that the asset management strategy is being executed. Nevertheless, 57% of small, 50% of medium and 55% of large municipalities do not have a process to monitor Plan implementation, though the greater part of municipalities is planning to establish one – Question 17. Coupled with this are the results of Question 32, which indicate that for the majority of municipalities, the AMP is not the main source of information for asset related decisions. On the positive side, 45% of large, 33% of medium and 21% of small municipalities have a process in place to monitor the AMP implementation.

The AMS provides the necessary structure to align organizational strategy and objectives to asset management strategy and objectives. It also provides a framework for asset management processes and practices and is essential for consistency and continuity of actions. However, only 18% of large municipalities have established an AMS and are monitoring its progress over time, according to Question 21. Twenty-nine percent of small, 67% of medium and 18% of large municipalities are planning to establish an AMS, while almost 30% of small and large municipalities have set up the elements and processes required to an AMS. From these results, it is clear that training concerning the System's set up and support for its implementation should be made available as soon as possible, especially for small and medium municipalities. Many AMS frameworks are available – the International Infrastructure Management Manual is one example – and implementation of AMSs must be encouraged.

Achieving RL 1 from the current averaged RL 0.36, would require small municipalities to better define and communicate the actions needed to achieve their asset management objectives. Some municipalities still need to implement and better communicate their Asset Management Policy. They might also want to establish a framework and start planning their AMS.

The current RL of medium-sized municipalities is 0.17, and in order to achieve RL 1, asset management objectives need to be clearly defined. The Asset Management Policy must be created and communicated, and municipalities might want to do more work on planning their AMSs – starting to set up some of the required elements and process would also help.

Large municipalities are currently on RL 1. However, moving forward to RL 2 implicates establishing a process to monitor AMP implementation. They should also reinforce and continue working on documenting and communicating the asset management objectives, in addition to improving the Asset Management Policy communication in the organization. More work needs to be done regarding the definition and communication of the necessary actions to achieve the asset management objectives, and the elements and processes required to an AMS must be set up.

5.4. People and Leadership

People and leadership is the competency with the highest readiness level across the respondent municipalities, and the one with the highest scores for small and medium municipal water utilities. If utilities are committed to implementing an AMS, this is the competency where progress could be demonstrated first and advance faster. Although small and medium municipalities have RL 0.79 and RL 0.5 respectively, their scores have slightly surpassed 1.5, indicating they might be just some adjustments away of advancing towards RL 1. Large municipalities seem to be consistently moving towards RL 2, with a RL 1.18 and score of 1.76. Their size allows larger staff capacity, better team structure, clearer definition of responsibilities, and more financial resources.

Comparatively, 43% of small, 33% of medium and 64% of large municipalities indicated they have an asset management team with members from different departments – Question 23. The total number of municipalities that reported having a team is a little higher, according to Question 3: 65% of small, 50% of medium and 73% of large municipalities. A somewhat different result was reported by PSD in its 2018 asset management data study: 32% of respondents had a dedicated asset management team and 15% had a dedicated employee (Public Sector Digest, 2018). These lower numbers might be explained by the national context of that survey, as opposed to the higher percentages in our Ontario study. Additionally, results from Question 22 show that 43% of small, 17% of medium and 46% of large municipalities have an accountable asset management team, but not all staff roles and responsibilities are defined. Medium municipalities have a worrisome scenario, where no asset management roles and responsibilities have been defined for 83% of respondents.

Question 24 encompassed council's support and commitment concerning asset management practices. For 57% of small, 50% of medium and 64% of large municipalities, council not only supports asset management practices, but also understands its requirements. These results resonate with the results obtained in Question 25, demonstrating that 57% of small, 50% of medium and 54% of large municipalities have allocated sufficient financial resources last year for the asset management planned actions. Once again, medium-sized municipalities have fallen behind, as for 50% of them the allocated financial resources were not sufficient to develop the asset management planned actions.

Small municipalities have a current averaged RL of 0.79. Achieving RL 1, entails continuing their work towards establishing cross-functional asset management teams and defining leadership roles and responsibilities. They should also increase awareness about financial resources availability to develop the asset management planned actions.

Medium-sized municipalities need to clearly define the roles and responsibilities regarding leadership for implementation, operation, monitoring and improvement of asset management if they want to move from a RL 0.5 to RL 1. They must also continue working towards setting up cross-functional asset management teams.

Finally, to progress from RL 1.18 to RL 2, large municipalities should clearly define leadership roles and responsibilities for implementation, operation, monitoring and improvement of asset management. Awareness concerning financial resources availability to develop asset management planned actions is also required.

5.5. Data and Information

Having good data and information invariably depends on financial resources for data collection and analysis. As expected, large municipalities are doing better than small and medium municipalities, with a RL 0.82 and score of 1.91, indicating that if they implement a handful of practices, they could easily move to RL 1. Despite having RLs closer to zero than one, the scores of small and medium municipalities are 1.39 and 1.47, respectively. It is clear from utilities' answers that data and information is a pivotal competency to the advancement of asset management in these organizations, and municipalities are investing in it. They already know what

to do, it is just a matter of being consistent and having financial resources and competent staff to implement the necessary practices.

Question 26 asked municipalities about the comprehensiveness of the data populating their asset inventories. Most small municipalities have basic (29%) and adequate (43%) asset data information, while medium-sized municipalities work with basic (67%) and adequate (16%) data information. Due to the extension of assets owned by large municipalities, they mostly deal with basic (46%) and adequate (36%) levels of asset data. These results are in line with the ones published by AWWA, indicating that 49% of water utilities work with basic data information in their assets' inventory (American Water Works Association, 2015).

Coupled with Question 26 is Question 30, inquiring about the purposes of data analysis. For most municipalities – 54% of small, 50% of medium and 64% of large – data analysis helps to determine asset condition and prioritization. Nevertheless, it is important to note that 31% of small and 50% of medium municipalities do not perform asset data analysis. Analyzing the asset data collected is crucial to create useful information to support asset related decisions.

Around 65% of all municipalities benefit from condition assessment practices to prioritize asset investments and improve decision-making – Question 29, which is extremely positive. One of the limitations of this study is that the extension of assets with condition assessment information is currently unknown. Nevertheless, PSD has reported in two different studies the percentage of assets with captured condition data. In the first study, 48% of respondents captured condition data for less than 50% of their linear assets. In contrast, only 28% municipal water utilities had condition data for more than 75% of linear assets (Public Sector Digest, 2018). The second study focuses on condition assessment methods. PSD reported that about 78% of water and wastewater assets have age-based condition assessment, whereas only 22% have assessed-based condition (Public Sector Digest, 2018). In any case, performing field condition assessment of buried infrastructure could be costly and operationally challenging, yet it yields crucial information for guiding investment prioritization.

Question 31 highlights the function of financial data to municipalities. It is important to note that only 36% of small, 33% of medium and 64% of large municipalities use financial data to identify funding gaps. This topic will be further discussed in Section 5.9, while LoS will be analyzed in Section 5.8.

Both small and medium municipalities should expand the use of asset data analysis to determine asset condition and prioritization, and also start defining current and proposed LoS in their AMPs if they want to move from RL 0.43 and RL 0.33 to RL 1, respectively. Similarly, for large municipalities to achieve RL 1 from the current RL 0.82, asset data analysis could gradually be used to set current and proposed LoS.

5.6. Planning and Decision-making

The planning and decision-making competency entails having formalized processes and documented planning to guarantee transparency in asset related decisions. Despite having high scores (1.55), small municipalities RL 0.43 shows they lack processes to structure these decisions. With RL 0.17 and scores of 1.43, medium-sized municipalities face the same challenges. Large municipalities seem to be doing a little better in comparison, with RL 0.55 and scores of 1.97.

According to FCM, 100% of Ontario municipalities have AMPs, as of 2019 (Scantlebury, 2019). Nevertheless, our survey identified 3 municipalities, from a total of 31, that still did not have water or wastewater AMPs – but were planning to develop it. This might have happened because it is challenging for FCM to check completion of all core infrastructure AMPs of its affiliated municipalities. Even so, in 2016 Ontario was the Province with the highest percentage of municipalities with an AMP – 95.6% against 38.5% in the rest of Canada (Statistics Canada, 2018). Ontario regulations were the key driver behind such a high percentage. However, for AMPs to be truly used as sources of information for asset decision-making, they need to be frequently updated and consider timeframes that are similar to assets' service life. Data from Question 13, about AMP updates, was more or less in line with data from CCPI survey, of 53% of Ontario municipalities updating their AMPs every one to five years, and 28% updating it every five years or more (Statistics Canada, 2018).

Geographic Information System (GIS) is still the main source of information for asset related decisions for the majority of municipalities, according to Question 32. Large municipalities have the higher percentages of using AMPs as the main source of information for planning and decision-making, which could be connected to the fact that they also update their AMPs at least every five years and have adopted longer timeframes for financial planning. The recent Ontario

Regulation 588/17 formalizes AMPs updates by requiring municipalities to update their AMPs at least every five years. This will also help municipalities to prioritize investment decisions, moving from prioritization based on council or management input and short-term needs to following investment plans with longer-term goals. According to the "Leveraging Asset Management Data for Improved Water Infrastructure Planning" survey, the top three approaches for investment prioritization are risk-based (financial, regulatory, technical), fiscal, and life cycle costing (Public Sector Digest, 2018).

Small municipalities need to establish a process to update the AMP, so it can be a source of information for decisions. Moreover, prioritization of investment decisions should follow the investment plans and more municipalities need to establish a process to identify funding gaps, if they want to move from RL 0.43 to RL 1.

With a current RL 0.17, medium-sized municipalities need to establish a process to update their AMPs, so it can be a source of information for decisions, if they aim to achieve RL 1. Municipalities also need to establish a process to identify funding gaps.

In the case of large municipalities, they should continue working on standardizing processes for decision-making prioritization and funding gap identification to move from RL 0.55 to RL 1. These processes need to be well communicated within the organization.

5.7. Contribution to Asset Management Practice

The contribution to asset management practice competency can sometimes be underestimated, as it relates to staff training and development, and to the way organizations share knowledge internally and actively participate in asset management external events. However, the scores for this competency were the lowest across all municipality sizes, indicating that processes need to be implemented so municipalities can progress.

Question 39 indicated that organizations that encourage staff's asset management development tend to be larger ones. Small and medium-sized municipalities seem to have a staff self-driven or short-term needs based approach to employees' development. Again, size and financial resources matter. The "2015 Establishing the Level of Progress in Utility Asset Management Survey Results", from AWWA, shows that for 51% of respondents, the majority of

staff and management have embraced asset management (American Water Works Association, 2015). This is key to motivate self-driven asset management development, but not enough to propel an entire organization to consistently advance on its asset management journey.

As several communities of practice, like the Institute of Asset Management and the Global Forum on Maintenance and Asset Management, have developed competence frameworks, asset management training based on competence evaluation is highly recommended so that organizations can have internal experts supporting organizational capacity. When asked whether municipalities have provided asset management training, guidance, mentoring or competence evaluation – Question 40, 33% of small, 67% of medium and 46% of large municipalities reported a "hit the ground running" approach. Yet, for large municipalities it somehow contradicts results from Question 39, where 55% of respondents reported that the organization selects and trains internal experts to support the development of organizational capacity. Nevertheless, this might be reinforced by results from Question 41, that demonstrate that knowledge is still concentrated in key people (18%), and that only now large municipalities are working to improve record keeping to mitigate the risk of losing information (37%). This pattern is less pronounced in small municipalities and very intense in medium-sized municipalities. Most municipalities attend at least one asset management event per year, according to results from Question 42 about external knowledge-sharing.

To achieve RL 1 and move forward from RL 0.46, small municipalities must encourage employee's development, especially by identifying longer-term requirements for training, guidance and competence evaluation.

However, medium-sized municipalities need to take a more active approach towards employees' development to advance from RL 0.33 to RL 1, by identifying longer-term requirements for training, guidance and competence evaluation. They must continue to mitigate the risk of losing information through improved record keeping. Municipalities should make an effort to attend at least one asset management event per year.

Finally, large municipalities should focus on actively providing employees with asset management training, guidance or competence evaluation to move from RL 0.55 to RL 1.

5.8. Ontario Regulation 588/17

One of the main requirements from Ontario Regulation 588/17 are for municipalities to develop an Asset Management Policy that includes considerations of climate change mitigation, adaptation and anticipated costs by July 2019, and to incorporate current and proposed LoS on AMPs by 2021 and 2024 respectively. The purpose is to expand on AMPs' requirements from the Ministry of Infrastructure's Building Together guidelines.

As of the beginning of 2019, 29% of small, 33% of medium and 28% of large municipalities did not have an Asset Management Policy – Question 19, even with the deadline of July 2019 quickly approaching. Surprisingly, even when municipalities had a Policy, it was not well communicated for 14% of small, 50% of medium and 27% of large municipalities, which can prevent these municipalities of aligning the organizational strategy with the asset management objectives.

Question 16 results revealed that for 40% of municipalities, climate change is not considered in asset management planning, and 17% reported that it is not clear how to put climate change actions into practice, even if they are considered in the organization's Policy. These results demonstrate a slight progress when compared with the 2016 CCPI survey, which indicated that for 56% of Ontario municipalities, climate change adaptation was not factored in the organization's decision-making process. In contrast, 24% of potable water asset owners and 34% of wastewater asset owners have factored climate change adaptation in their decision-making process (Statistics Canada, 2018). These results appear to be closer to the ones at the 2016 CIRC, where climate change adaptation strategies were formally factored-in for water (14%) and wastewater (16%) assets (Federation of Canadian Municipalities, 2016). Clearly, much still needs to be done regarding connecting climate change and infrastructure asset management.

For 31% of small, 50% of medium and 18% of large municipalities, LoS are not specified in their AMPs, according to Question 15. On the positive side, 60% of all municipalities have already documented LoS in their AMPs. The results for Ontario are much better than the results reported by AWWA, stating that only 32% of municipalities in North America have developed and documented LoS. AWWA also indicated that approximately half of respondents have targets for LoS, but only 14% of them are regularly measuring and communicating its progress (American Water Works Association, 2015).

5.9. Water and Wastewater Infrastructure Funding Gaps

One of the most important benefits of good asset management practices is being able to accurately identify funding gaps. As demonstrated in Question 35, about one-third of small and medium municipalities and 9% of large municipalities do not have a process in place to identify funding gaps. Furthermore, because less than 20% of municipalities report having no funding gaps, it is safe to assume that a great proportion of municipalities do have funding gaps.

There are many challenging aspects of dealing with funding gaps. The first one is identifying them through a reliable process. Many municipalities conscientiously avoid sizing their funding deficiencies because then they would be obliged to do something about it. This seems extremely counterproductive, but it is based on this researcher's personal experience in interacting with municipalities in asset management workshops and trainings. Second is the fact that the most employed mechanism for covering funding gaps is increasing user fees – as illustrated in Questions 37 and 38. This tends to damage council's image and trust, as most citizens do not understand water and wastewater infrastructure cost trade-offs. Next is that increased asset deterioration and larger infrastructure backlogs, as seen in Sections 2.2 and 2.3, rises intervention costs exponentially, as asset maintenance, renewal or replacement are more expensive if assets are in poorer condition. Finally, it is important to distribute infrastructure investment costs in time, particularly when covering funding gaps, to promote inter-generation affordability of user fees. All in all, it is crucial to support accurate funding gap identification and funding mechanisms to span it, without overburdening users.

Chapter 6
Conclusions and Recommendations

6.1. Conclusions

This research investigated the asset management processes and practices implemented by municipalities to manage their water and wastewater assets. A methodology for assessing asset management readiness levels was developed and applied to 31 municipalities in Ontario. Additionally, an industry report presenting the survey results was made available in the Spring of 2019, aiming to inform asset management policies, regulations and guidelines. Based on the data provided by these 31 municipalities, the main findings of this research are as follows:

(a) Small municipalities are still on their way towards Readiness Level 1, as most respondents were classified into Readiness Level 0. They are steadily implementing asset management processes, but are limited by financial resources and staff capacity.

(b) Medium-sized municipalities have been classified as Readiness Level 0 in all competency areas. These municipalities have fallen behind small municipalities regarding averaged Readiness Levels and Scores, indicating they have less advanced asset management processes in place. Medium-sized municipalities are rarely the focus of government support, yet they seem to lack the capacity and robustness of large municipalities to have enough resources and structure to implement good asset management practices.

(c) Large municipalities, on the other hand, have achieved Readiness Level 1 for the policy and governance and the people and leadership competencies, and are steadily moving towards Readiness Level 2. They are still at Readiness Level 0 for the remaining competencies, but their high scores are an indicative of advanced asset management processes. They are gradually structuring Asset Management Systems and focus on staff development to support organizational capacity.

(d) Asset Management Plans are increasingly being used as sources of information for evidence-based decision-making, but are still surpassed by GIS or other tool that

aggregates asset data. The quality of data populating the Plan and the frequency of document updates could be increased, so Asset Management Plans become live documents and therefore fit to inform asset decisions.

(e) Climate change is still not fully integrated into asset management planning and decision-making processes. Given the importance of not only safeguarding water and wastewater infrastructure, but also keeping them operational during or shortly after intense weather events, guidelines on "how to" integrate climate change aspects and impacts to asset management planning are paramount.

(f) The Asset Management System provides the necessary structure and alignment with organizational strategy and objectives. As many municipalities are still in the process of structuring their AMSs, training and guidance for System's implementation should be made available as soon as possible.

(g) Legislative requirements have been fundamental to advance asset management practices in Ontario. Measuring municipalities' progress in implementing regulatory requirements is essential to keep a balance between these requirements and the available asset management funding, guidance and trainings.

(h) The "Water and Wastewater Asset Management Readiness Assessment" survey was very successful, even more when considering the water sector survey fatigue. The survey reached the response goals of a minimum of 30 municipalities representing 50% of the Ontario population, in addition to obtaining a high response rate of 20%, with quality responses from water municipal asset managers – consequence of the tailored distribution list. Survey results fill a gap regarding information about water utilities asset management current practices.

(i) This Readiness Assessment methodology has proven to be effective and efficient in gauging municipalities' processes and practices. It has no limitations concerning Provincial boundaries, and it is ready to be rolled out nationally after minor adaptations to the questionnaire.

6.2. Recommendations for Future Work

This research has established the asset management readiness level baseline in Ontario for small, medium and large municipal water utilities. As with any newly developed methodology, challenges were faced for its application in the municipal context. Recommendations for future work are as follows:

(a) Apply the survey every other year in Ontario to keep track of municipalities' asset management progress. The questionnaire should be revised to exclude most of the background questions used to identify municipalities if the asset managers' e-mail list should be the main distribution method.

(b) Focus on increasing small and medium-sized municipalities participation in future studies in Ontario. Partnerships with asset management communities of practice might be of great help.

(c) Gradually expand the outcome possibilities for questions' alternatives to encompass more advanced asset management processes and practices, beyond Readiness Level 3.

(d) Explore the possibility of applying a tailored survey to small municipalities, given that they face different asset management challenges when compared to large municipalities. Additionally, 62% of the 444 Ontario municipalities have between 1,000 and 30,000 people, and besides this research, not much is known about their current asset management processes and practices. Adapting the questionnaire by removing most of the non-scorable questions and therefore reducing the time for survey completion would be relatively easy and more adequate to small municipalities needs.

(e) Roll out a national survey for assessing the readiness levels and scores of water utilities regarding their asset management practices. Partnerships with asset management communities of practice would be crucial to develop a comprehensive distribution list.

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Appendix A – Survey Questionnaire

Background Questions

1. What is the size of population served by your municipality or utility?

- Very small: less than 5,000 people
- Small: less than 29,999 people
- Medium: 30,000 to 99,999 people
- Large: 100,000 to 399,999 people
- Very large: more than 400,000 people

2.What is the classification of your municipality regarding lower-, upper and single-tier?

Lower-tier municipalities: in this case, another level of municipal government, for instance a county or region, is involved in providing services to residents.

Upper-tier municipalities: provide services, such as arterial roads; transit; policing; sewer and water systems; waste disposal; region-wide land use planning and development; health and social services.

Single-tier municipalities: have responsibilities for all local services to their residents.

Definition by AMO (Association of Municipalities Ontario)

- Lower-tier
- Upper-tier
- Single-tier
- I am not sure

3. Does your organization have an asset management team?

Asset management team: a group of representatives from different departments who conduct AM duties. (FCM)

- No
- Not yet, but we have the intention or are in the process of establishing one
- Yes, it was created less than 2 years ago
- Yes, it was created more than 2 years ago
- Does not apply
- I am not sure

4. Which asset types are managed by your asset management team?

Mark all alternatives that apply. The "does not apply" option excludes all other alternatives.

- Water pipelines
- Water treatment facilities; storage tanks (after water treatment); water pump stations
- Wastewater pipelines
- Wastewater treatment facilities; wastewater pump stations
- Storm water: pipelines and ponds
- Roads
- Does not apply
- I am not sure

Strategic Vision and Asset Management Plan

This section addresses the organization's strategic vision and its connection with asset management, as well as information on Asset Management Plans.

5. Is asset management part of your organization's strategic plan?

Asset Management: coordinated activity of an organization to realize value from assets. (definition by ISO 55000)

Strategic plan: a document that establishes broad organizational goals and a sequence of steps to achieve them, as well as resource allocation.

- No, asset management is not considered in the organization's strategy and goals
- I think so, but the connection between asset management and the organization's goals is not clear
- Yes, there is a clear connection between the organization's strategy and goals with asset management, but resource allocation has not been defined
- Yes, there is a clear connection between the organization's strategy and goals with asset management, and resource allocation is defined
- I am not sure

6. Does asset management add value to your organization's business?

Mark all alternatives that apply. The "No" alternative excludes all other alternatives.

Value, in this case, is connected to benefits. Some possible values are: improved financial performance, informed asset investment decisions, risk management, improved services and outputs, demonstrated social

responsibility, demonstrated compliance, enhanced reputation, improved organizational sustainability, improved efficiency and effectiveness.

- No, asset management does not bring noticeable value
- Yes, it helps to reduce costs (improves financial performance)
- Yes, it allows us to get government funding
- Yes, it helps in decision making
- Yes, it helps with risk management
- Yes, it helps to address climate change
- Yes, it improves service performance
- Yes, it helps with social responsibility
- Yes, it helps with compliance
- Yes, it improves the organization's reputation
- Yes, it improves organizational sustainability
- Yes, the organization is more efficient and effective
- I am not sure

7. Has your organization completed an asset management maturity/readiness assessment?

Asset management maturity/readiness tool places the organization in a maturity/readiness scale by means of structured questions based on a specific framework or regulatory requirements.

- Not done
- Not done, but we are planning to perform readiness assessment
- Yes, using an internal/alternative framework
- Yes, using FCM's asset management framework
- Yes, using an ISO 55000 based framework
- Yes, using a PAS55 based framework
- Yes, using another industry-based framework
- I am not sure

8. Does your organization have an Asset Management Plan?

Asset Management Plan: a strategic document that states how a group of assets is to be managed over a period of time. The plan describes the characteristics and condition of infrastructure assets, the Levels of Service expected from them, planned actions to ensure that the assets provide the expected level of service, and financing strategies to implement the planned actions. (Building Together - Guide for municipal Asset Management Plans)

- No
- No, but we are planning to develop an Asset Management Plan
- Yes, but the plan is not taken in consideration in the decision-making process
- Yes, and sometimes decisions are based on the plan
- Yes, and the plan is fully integrated with the organization's decision-making processes
- I am not sure

9. What is the main reason your organization developed an Asset Management Plan?

- To have access to government funding
- To comply with regulatory requirements or guidelines
- To satisfy organization's policy
- To serve as a guide/plan for how the organization's assets should be managed
- Does not apply
- I am not sure

10. Who completed your organization's Asset Management Plan?

- The plan was completed internally
- The plan was completed by a consultant
- The plan was jointly completed by a consultant and internal resources
- Does not apply
- I am not sure

11. How much did your Asset Management Plan cost?

- ≤$20,000
- >$20,000 to ≤ $40,000
- >$40,000 to ≤$60,000
- >$60,000 to ≤$80,000
- >$80,000 to ≤$100,000
- >$100,000
- Does not apply
- I am not sure

12. How long has your organization had an Asset Management Plan?

- ≤2 years
- >2 to ≤4 years
- >4 to ≤6 years
- >6 years
- Does not apply
- I am not sure

13. How often is your Asset Management Plan updated?

- Every 1 to ≤3 years
- Every >3 to ≤5 years
- >5 years
- Does not apply
- I am not sure

14. What is the asset timeframe considered in your Asset Management Plan?

- 5 years
- 10 years
- 15 years
- 20 years
- More than 20 years
- Does not apply
- I am not sure

15. Are the assets' level of service (LoS) specified in your Asset Management Plan?

Level of Service: outline the overall quality, function, capacity and safety of the service being provided and represent the minimum condition that assets should be maintained at during their lifecycle. (based on SUMA and Richmond Hill Asset Management Plan)

- No, the plan does not state the level of service
- No, but we are planning to add the level of service
- Yes, the plan states the level of service according to regulatory requirements
- Yes, the plan states the level of service according to regulatory and technical requirements
- Does not apply

- I am not sure

16. What aspects of climate change are considered by your organization in Asset Management Planning?

Mark all alternatives that apply. The “does not apply” option excludes all other alternatives.

- Climate change was not considered in Asset Management Planning
- Climate change is considered in our policy, however it is not clear how to put that into action
- Anticipated costs
- Mitigation and adaptation approaches
- Risk and disaster planning
- Does not apply
- I am not sure

17. Does your organization have a process to monitor the implementation of your Asset Management Plan?

Asset Management Plan implementation: planning and implementation of the Asset Management Plan's recommended actions, which are necessary to the advancement of asset management in the organization.

- No
- No, but we are planning to establish a process to monitor plan implementation
- Yes, our organization monitors the plan implementation through an established process
- Yes, plan implementation is overseen by the organization and the council, through an established process
- Does not apply
- I am not sure

Policy and Governance

This competency involves putting in place policies and objectives related to asset management, bringing those policies to life through a strategy and framework, and then measuring and monitoring implementation over time. (FCM's Asset Management Readiness Scale)

18. Does your organization have defined asset management objectives?

The Strategic Asset Management Plan (SAMP) or Asset Management Strategy should document the relationship between the organizational objectives and the asset management objectives, and should define the framework required to achieve the asset management objectives.

Asset Management Objectives: the goals to be reached by the asset management system, such as to expand the Asset Management Plan for non-core assets; to extend the financial planning from 5 to 20 years; to complete pipe inspection to determine condition grade, etc. Definition by ISO55002 (modified).

- o No
- o Yes, but asset management objectives are not well documented or communicated
- o Yes, asset management objectives are well documented, communicated and consistent with the organization's objectives
- o Yes, asset management objectives are well documented, communicated, and are consistent with the organization's objectives and additional requirements (technical, financial, regulatory, etc.)
- o I am not sure

19. Does your organization have an Asset Management Policy?

Asset management policy: a document that sets out the principles by which the organization intends to apply asset management to achieve its organizational objectives. The policy should set out the organization's commitments and expectations for decisions, activities and behavior concerning asset management. Definition by ISO55002.

- o No
- o Yes, but it is not well communicated within the organization
- o Yes, and it is well communicated within the organization
- o Yes, it is well communicated within the organization and provides a framework for asset management objectives
- o I am not sure

20. Did your organization define the necessary actions to achieve its asset management objectives?

- o No
- o Yes, but the actions are not well communicated within the organization
- o Yes, the actions are well communicated within the organization
- o Yes, the actions are well communicated within the organization and updated when necessary
- o I am not sure

21. Has your organization established an Asset Management System?

Asset Management System: a set of interrelated and interacting elements of an organization, which has the function of establishing the Asset Management Policy and asset management objectives, and the processes needed to achieve those objectives. Definition by ISO55000.

- o No
- o No, but we are planning to establish an Asset Management System
- o Yes, we have set up the elements and processes required to an Asset Management System

- Yes, we have established an Asset Management System and are measuring and monitoring its progress over time
- I am not sure

People and Leadership

This competency involves setting up cross-functional groups with clear accountability, and ensuring adequate resourcing and commitment from senior management and elected officials to advance asset management. (FCM's Asset Management Readiness Scale)

22. Does your organization have clearly defined roles and responsibilities regarding leadership for implementation, operation, monitoring and improvement of asset management?

- No
- Yes, there are people responsible for asset management, but roles and responsibilities are not defined
- Yes, there is an accountable asset management team, but not all roles and responsibilities are defined
- Yes, there is an asset management team and their roles and responsibilities are clearly defined
- I am not sure

23. Has your organization established an asset management team with members from different departments?

- No asset management human resources were appointed so far
- Not yet, but the organization has appointed human resources to define and introduce an appropriate asset management framework
- The organization has established an asset management team, but it does not comprise human resources from different departments
- Yes, an asset management team with human resources from different departments is established
- I am not sure

24. Does your organization have council's support and commitment concerning asset management practices?

- o No
- o Yes, but council is not aware of asset management practices requirements
- o Yes, council demonstrates buy-in and support for asset management
- o Yes, council champions asset management as a core business function
- o I am not sure

25. Did your organization allocate sufficient financial resources last year to develop the Asset Management Planned actions?

Example of Asset Management Planned actions: employee training, equipment acquisition, establishing an AM team, etc.

- o No, asset management financial resources were not approved by council
- o No, the allocated financial resources were not sufficient to develop the planned actions
- o Yes, but the planned actions only comprised priority improvements to the asset management system
- o Yes, there were sufficient financial resources to support the Asset Management Planned actions
- o I am not sure

Data and Information

This competency involves using asset data, performance data and financial data to support effective Asset Management Planning and decision-making. (FCM's Asset Management Readiness Scale)

26. Does your organization have asset data inventory?

Limited: some attributes (e.g. ID, age) for key assets.

Basic: some attributes for all assets.

Adequate: sufficient attributes for all assets.

Comprehensive: sufficient attributes for all assets linked to performance information (e.g. number of breaks).

- o No, the organization works with limited asset data information
- o Yes, the organization works with basic asset data information
- o Yes, the organization works with adequate asset data information
- o Yes, the organization works with comprehensive asset data information
- o I am not sure

27. What is the confidence level in your organization regarding asset data inventory?

- Water pipelines (Low/Medium/High/Very High/(N/A))
- Water treatment facilities; storage tanks (after water treatment); water pump stations (Low/Medium/High/Very High/(N/A))
- Wastewater pipelines (Low/Medium/High/Very High/(N/A))
- Wastewater treatment facilities; wastewater pump stations (Low/Medium/High/Very High/(N/A))
- Storm water: pipelines and ponds (Low/Medium/High/Very High/(N/A))
- Roads (Low/Medium/High/Very High/(N/A))

28. What tools are used by your organization to manage assets and data?

Mark all alternatives that apply.

- I am not sure
- GIS
- IBM Maximo
- Cityworks
- Infor Hansen
- Riva/PowerPlan
- Excel
- Microsoft Access
- Oracle Enterprise Asset Management
- InfraModex
- Other (please specify)

29. What is the main benefit your organization can derive from the current asset condition assessment practices?

- None, the organization has not established a process for condition assessment
- Improved operation services
- Inventory and criticality update
- Asset investment prioritization and improved decision-making
- I am not sure

30. Does your organization perform asset data analysis?

- o No, the organization works with limited asset data information and analysis, mostly used for operation and maintenance
- o Yes, data analysis helps to determine asset condition and prioritization
- o Yes, data analysis helps to determine current Levels of Service
- o Yes, data analysis combines different data inputs to determine proposed Levels of Service
- o I am not sure

31. How is financial data used in your organization?

PSAB-3150: is the Public Sector Accounting Board's standard guiding the treatment of tangible capital assets.

Mark all alternatives that apply.

- o For yearly PSAB-3150 reporting requirements
- o To set capital and operational expenditures
- o To determine costs to maintain current Levels of Service
- o To identify future needs and funding gaps
- o I am not sure

Planning and Decision-making

This competency involves documenting and standardizing how the organization sets asset management priorities, conducts capital and operations and maintenance (O&M) planning, and decides on budgets. (FCM's Asset Management Readiness Scale)

32. What is the main asset management source of information for planning and decision-making in your organization?

- o There is no tool or source of information in place to manage assets
- o GIS or other software that aggregates data
- o Asset Management Plan
- o Asset Management Plan aligned with the asset investment plan
- o I am not sure

33. Has your organization established a process to address the new 588/17 Ontario Regulation?

588/17 Ontario Regulation: urges municipalities to prepare a Strategic Asset Management Policy by July 2019. Said policy must include "the process by which the Asset Management Plan is to be considered in the development of the municipality's budget or of any long-term financial plans…".

- o No, the organization needs help to understand the regulation's implications
- o No, but the organization is starting to connect the Asset Management Plan with municipality's budget
- o Yes, the process for considering Asset Management Plan in the municipality's budget is already in place
- o I am not sure

34. How does your organization prioritize asset management investment decisions?

- o Priority evaluation is based on experience, council and management input, and available information
- o Prioritization usually addresses short-term needs and teams set priorities independently of each other
- o Prioritization follows asset investment plans and are based on organizational objectives
- o Prioritization follows asset investment plans and balance the current Levels of Service with longer-term goals and risks
- o I am not sure

35. Does your organization have a process in place to identify possible future funding gaps?

- o None, budgeting and capital investments are based on current needs.
- o Yes, financial planning for capital investment is based on population growth.
- o Yes, short-term (less than 5 years) financial planning for capital and operational expenditures is based on current Levels of Service
- o Yes, long-term (more than 10 years) financial planning associated with asset lifecycle and Levels of Service
- o I am not sure

36. Has a funding gap been identified for any of the following assets?

Please choose the percentage of the funding gap related to the timeframe and total budget identified for each asset type managed by your organization.

- Water (No gap / >0% - ≤20% / >20% - ≤40% / >40% / Not sure / (N/A))
- Wastewater (No gap / >0% - ≤20% / >20% - ≤40% / >40% / Not sure / (N/A))
- Storm water (No gap / >0% - ≤20% / >20% - ≤40% / >40% / Not sure / (N/A))
- Roads (No gap / >0% - ≤20% / >20% - ≤40% / >40% / Not sure / (N/A))
- Other (please specify)

37. If a funding gap has been identified, how does the organization plan to cover it?

- Using government grants and funding
- By increasing the user fee
- Using revenue from other assets (i.e. using water fee to cover road and/or storm water expenses)
- Does not apply
- I am not sure

38. Is your organization planning on increasing your water or wastewater user fees for the next 10 years?

- No
- Yes, according to the inflation rate
- Yes, from >0% to ≤20%
- Yes, from >20% to ≤50%
- Yes, >50%
- Does not apply
- I am not sure

Contribution to Asset Management Practice

This competency involves asset management training and developing employees, sharing knowledge internally and participating in external knowledge sharing. (FCM's Asset Management Readiness Scale)

39. Does your organization encourage employees' asset management development?

- No, asset management development approach is informal and largely driven by the initiative of team members
- Yes, but asset management development requirements are based on short-term needs (e.g. regulatory requirements)

- Yes, the organization promotes basic asset management awareness training to all employees
- Yes, the organization selects and trains internal experts to support the development of organizational capacity
- I am not sure

40. Did your organization provide asset management training, guidance/mentoring or competence evaluation?

- No, it had a "hit the ground running" approach
- Yes, it provided guidance through in-house asset management meetings/workshops
- Yes, it provided training by hiring specialized third parties or sending human resources to external training sessions
- Yes, it evaluated the competences needed and provided training and guidance based on them
- I am not sure

41. Does your organization encourage internal asset management knowledge sharing?

- No, asset management knowledge and information are concentrated in key people
- Yes, the organization is mitigating the risk of losing information through improved record keeping
- Yes, the organization is structuring asset management knowledge sharing resources
- Yes, asset management knowledge and information are freely shared throughout the organization
- I am not sure

42. Does your organization participate in asset management events?

- No, the organization does not attend asset management events
- Yes, the organization attends at least one event every year
- Yes, the organization attends at least one event per year and constantly searches for knowledge sharing opportunities
- Yes, the organization actively participates in asset management events and shares its experience with peers
- I am not sure

Specific Background Questions

43. Does your organization manage any of the following asset categories?

Mark all alternatives that apply. The "Does not apply" option excludes all other alternatives.

- o Water treatment facilities; storage tanks (after water treatment); water pump stations
- o Water pipelines
- o Wastewater treatment facilities; wastewater pump stations
- o Wastewater pipelines
- o Storm water: pipelines and ponds
- o Roads
- o Does not apply
- o I am not sure

44. What is the estimated replacement value of your organization's water treatment facilities, storage tanks (after water treatment), and water pump stations?

- o Less than $200 million
- o Between $200 and $500 million
- o Between $500 million and $1 billion
- o Greater than $1 billion
- o Does not apply
- o I am not sure

45. What is the estimated replacement value of your organization's potable water pipelines?

- o Less than $200 million
- o Between $200 and $500 million
- o Between $500 million and $1 billion
- o Greater than $1 billion
- o Does not apply
- o I am not sure

46. What is the estimated replacement value of your organization's wastewater treatment facilities and wastewater pump stations?

- Less than $200 million
- Between $200 and $500 million
- Between $500 million and $1 billion
- Greater than $1 billion
- Does not apply
- I am not sure

47. What is the estimated replacement value of your organization's wastewater pipelines?

- Less than $200 million
- Between $200 and $500 million
- Between $500 million and $1 billion
- Greater than $1 billion
- Does not apply
- I am not sure

48. What is the estimated total length of potable water pipelines managed by your organization?

- Less than 100Km
- Between 100 and 299Km
- Between 300 and 499Km
- Between 500Km and 799Km
- Greater than 800Km
- Does not apply
- I am not sure

49. What is the estimated total length of storm water linear assets managed by your organization?

- Less than 100Km
- Between 100 and 299Km
- Between 300 and 499Km
- Between 500Km and 799Km
- Greater than 800Km
- Does not apply
- I am not sure

Identification of target population

50. What is your department?

Choose one alternative. If none of them apply choose "Other" and specify.

- Engineering
- Planning
- Operations
- Finance
- Asset Management
- Other (please specify)

51. Please provide your job title or the closest applicable designation presented on the alternatives.

Choose one alternative. If none of them apply choose "Other" and specify.

Specific AM Group: oversees one asset type

Corporate AM Group: oversees more than one asset type

- Director (Specific AM Group / Corporate AM Group)
- Manager (Specific AM Group / Corporate AM Group)
- Analyst/Specialist (Specific AM Group / Corporate AM Group)
- Technician (Specific AM Group / Corporate AM Group)
- Other (please specify)

52. In relation to asset management decisions, my responsibilities:

- Have no connection with asset management decisions
- Influence asset management decisions
- Include being part of a group that is responsible for asset management decisions

- Include being responsible for the development and implementation of decisions
- Does not apply
- I am not sure

53. Did you use information or input from other departments besides your own to answer the survey?

Choose one alternative. If the "Yes" alternative applies, please specify.

- No, the information was provided based on what was available within my department
- No, the information used to answer the survey is shared among departments and was readily available
- Yes. Please provide the department:

54. Would you like to receive a report comparing your organization's level of readiness with that of other respondents in the same size category, in an aggregated format and after all the data is compiled?

- No
- Yes. Please leave your e-mail here_____

Appendix B – Introductory Text to the Survey

"The survey goal is to understand how municipalities are assimilating and implementing asset management practices in the water industry, especially in the face of new regulations and guidelines. The findings of this study will be made available in an easy-to-read report in order to support the advancement of asset management in Ontario.

This project was developed by Anelisa Schmidt, a graduate student from the University of Waterloo, under the supervision of Dr. Mark Knight, with support from the Centre for Advancement of Trenchless Technology (CATT) and the Southern Ontario Water Consortium (SOWC).

The survey is designed to be answered by municipality's asset managers, takes 30 to 60 minutes to be completed and is as jargon-free as possible. Thirty (30) out of the fifty-four (54) questions have the purpose of placing the municipality in a readiness scale. Therefore, the main benefit for survey participants is the opportunity to benchmark the organization's Asset Management Readiness Score against the aggregated responses from water utilities of similar size - after all data is collected and compiled.

Respondents can complete the survey in parts or modify it at any time, since answers are automatically saved from your last access. All survey responses are strictly confidential and will only be displayed publicly in an aggregated format.

That being said, we kindly invite municipal asset management practitioners to fill out the survey. The deadline is September 14th, 2018 - 6pm ET.

Do not hesitate to contact Anelisa Schmidt (asilvasc@uwaterloo.ca) if you have any questions regarding this survey.

Thank you for your time and input!"

Appendix C – Benchmark Report Sample

Benchmark Report

2018 Water and Wastewater Asset Management Readiness Assessment Survey

Thank you for completing the survey. This benchmark report will help you to assess your organization's results against the aggregated results of municipalities in the same size category.

RESPONDENTS' BACKGROUND

31 municipalities
6,803,276 people
50.6% ON population

Small
<29,999
14 municipalities
Population: 166,842

Medium
30,000 to 99,999
6 municipalities
Population: 285,524

Large
>100,000
11 municipalities
Population: 6,350,910

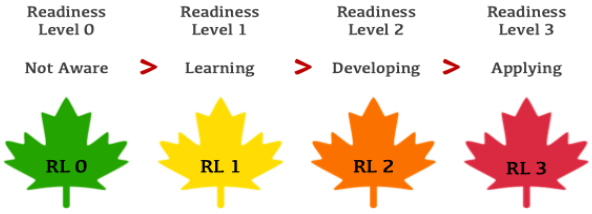
9 Single-tiers
6 Upper-tiers
16 Lower-tiers

METHODOLOGY

Organizations are scored in five competency areas:

- Policy and Governance
- People and Leadership
- Data and Information
- Planning and Decision-making
- Contribution to Asset Management Practice

The Readiness Level (RL) is assessed for each one of the competency areas.



Lower RLs do not necessarily mean assets are not being managed, though they suggest that work should be done in respect to formalizing and standardizing practices.

IMPORTANT TO KNOW

- The readiness level descriptions can be found on page 3
- Any "I am not sure" response grants a RL = 0 for the correspondent competency area
- To be classified in a specific RL, all outcomes for this level must be achieved
- The objective of this assessment is to create awareness towards asset management capacity and to provide a simple tool for municipal water utilities. It is not the intent of this project to replace any of the existing and more detailed assessment tools.
- Your survey responses can be found from page 4 onwards
- We recommend that you check our Water and Wastewater Asset Management Readiness Assessment Report for a complete profile on Ontario municipal water utilities asset management practices. The report was sent to you by e-mail together with this Benchmark Report.

Respondent #2

Municipality size: Large (more than 100,000 people)

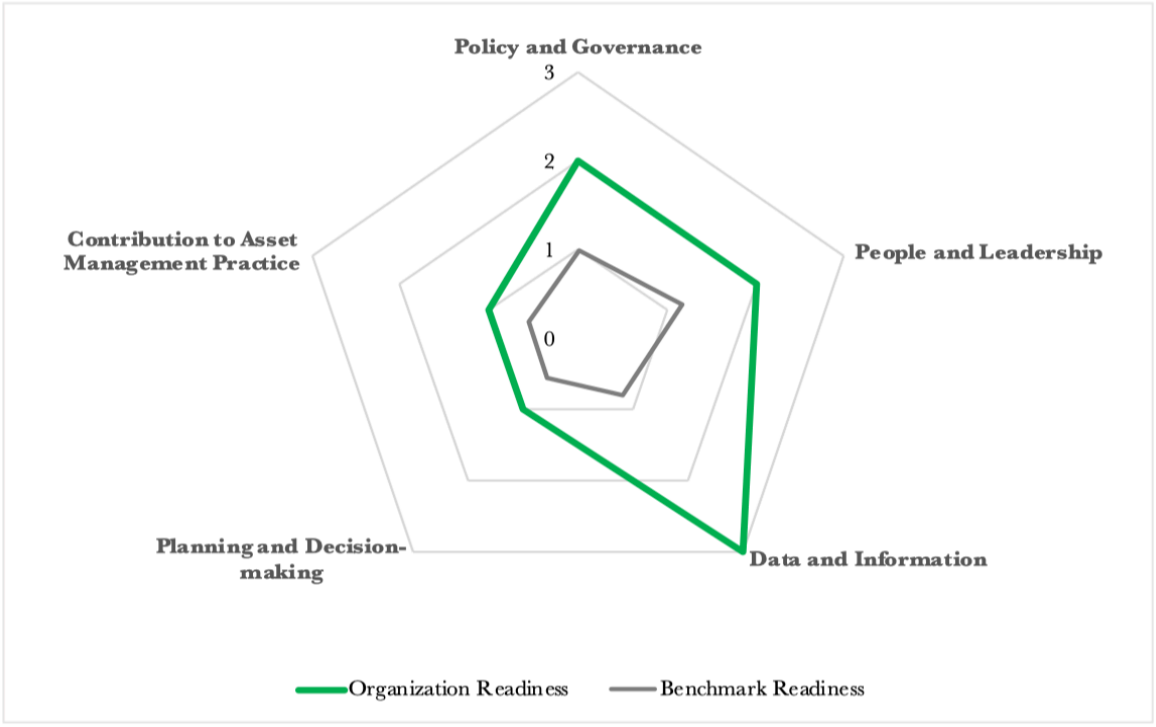
Total number of respondents: 11 municipalities

Competencies	RL Benchmark	RL Organization	Score Organization
Policy and Governance	1	2	2.67
People and Leadership	1.18	2	2.60
Data and Information	0.82	3	3.00
Planning and Decision-making	0.55	1	2.43
Contribution to Asset Management Practice	0.55	1	2.50

Your organization's score represents the average marks per competency, or how close your organization is of reaching a specific Readiness Level (RL).

The Readiness Level (RL) of your organization is always an integer value (0, 1, 2 or 3) reflecting the question that got the lowest mark for each competency area. Remember that to be classified in a specific RL (1, 2 or 3) one must fulfill all outcomes required for that RL.

The benchmark Readiness Level (RL) depicts the average of the individual RLs of all organizations in the same size category – including yours.



Note: Following this are the readiness level description and the municipality's responses to the questionnaire.

Appendix D – Tabulated Results

Unless noted otherwise, the number (N) of respondents in the tables below are as follows: $N_{Small} = 14$; $N_{Medium} = 6$; $N_{Large} = 11$.

Question 3: Does your organization have an asset management team?

Question 3	Small	Medium	Large
No	14%	17%	18%
Not yet, but we have the intention or are in the process of establishing one	14%	33%	9%
Yes, it was created less than 2 years ago	21%	17%	18%
Yes, it was created more than 2 years ago	43%	33%	55%
Does not apply	0%	0%	0%
I am not sure	7%	0%	0%

Question 5: Is asset management part of your organization's strategic plan?

Question 5	Small	Medium	Large
No, asset management is not considered in the organization's strategy and goals	7%	0%	0%
I think so, but the connection between asset management and the organization's goals is not clear	50%	17%	0%
Yes, there is a clear connection between the organization's strategy and goals with asset management, but resource allocation has not been defined	29%	67%	64%
Yes, there is a clear connection between the organization's strategy and goals with asset management, and resource allocation is defined	14%	0%	36%
I am not sure	0%	17%	0%

Question 6: Does asset management add value to your organization's business?

Question 6*	All respondents
Yes, it helps in decision making	81%
Yes, it allows us to get government funding	71%
Yes, it helps with risk management	68%
Yes, it improves organizational sustainability	68%
Yes, it improves service performance	65%
Yes, it helps with compliance	65%
Yes, the organization is more efficient and effective	55%
Yes, it helps to reduce costs (improves financial performance)	52%
Yes, it improves the organization's reputation	45%
Yes, it helps with social responsibility	42%
Yes, it helps to address climate change	39%
I am not sure	6%
No, asset management does not bring noticeable value	3%

* Mark all that apply question type

Question 7: Has your organization completed an asset management maturity/readiness assessment?

Question 7	Small	Medium	Large
Not done	29%	33%	9%
Not done, but we are planning to perform readiness assessment	7%	17%	0%
Yes, using an internal/alternative framework	7%	0%	18%
Yes, using FCM's asset management framework	7%	17%	18%
Yes, using an ISO 55000 based framework	7%	0%	36%
Yes, using a PAS55 based framework	0%	0%	0%
Yes, using another industry-based framework	7%	0%	0%
I am not sure	36%	33%	18%

Question 8: Does your organization have an Asset Management Plan?

Question 8	Small	Medium	Large
No	0%	0%	0%
No, but we are planning to develop an Asset Management Plan	14%	17%	0%
Yes, but the plan is not taken in consideration in the decision-making process	21%	50%	27%
Yes, and sometimes decisions are based on the plan	50%	17%	27%
Yes, and the plan is fully integrated with the organization's decision-making processes	14%	17%	36%
I am not sure	0%	0%	9%

Question 9: What is the main reason your organization developed an Asset Management Plan?

Question 9	Small	Medium	Large
To satisfy organization's policy	0%	0%	0%
To have access to government funding	21%	17%	18%
To comply with regulatory requirements or guidelines	36%	50%	18%
To serve as a guide/plan for how the organization's assets should be managed	43%	33%	64%
Does not apply	0%	0%	0%
I am not sure	0%	0%	0%

Question 10: Who completed your organization's Asset Management Plan?

Question 10	Small	Medium	Large
The plan was completed by a consultant	21%	33%	27%
The plan was completed internally	29%	33%	45%
The plan was jointly completed by a consultant and internal resources	43%	33%	27%
Does not apply	0%	0%	0%
I am not sure	7%	0%	0%

Question 11: How much did your Asset Management Plan cost?

Question 11	Small	Medium	Large
≤$20,000	29%	0%	0%
>$20,000 to ≤ $40,000	7%	17%	0%
>$40,000 to ≤$60,000	0%	0%	0%
>$60,000 to ≤$80,000	7%	0%	0%
>$80,000 to ≤$100,000	21%	0%	0%
>$100,000	0%	0%	36%
Does not apply	0%	17%	0%
I am not sure	36%	67%	64%

Question 12: How long has your organization had an Asset Management Plan?

Question 12	Small	Medium	Large
≤2 years	0%	0%	9%
>2 to ≤4 years	14%	17%	18%
>4 to ≤6 years	50%	67%	45%
>6 years	14%	17%	27%
Does not apply	0%	0%	0%
I am not sure	21%	0%	0%

Question 13: How often is your Asset Management Plan updated?

Question 13	Small	Medium	Large
Every 1 to ≤3 years	7%	0%	36%
Every >3 to ≤5 years	29%	33%	55%
>5 years	29%	17%	0%
Does not apply	0%	33%	0%
I am not sure	36%	17%	9%

Question 14: What is the asset timeframe considered in your Asset Management Plan?

Question 14	Small	Medium	Large
5 years	7%	0%	0%
10 years	21%	33%	27%
15 years	0%	0%	0%
20 years	14%	17%	0%
More than 20 years	43%	17%	55%
Does not apply	0%	0%	0%
I am not sure	14%	33%	18%

Question 15: Are the assets' level of service specified in your Asset Management Plan?

Question 15	Small*	Medium	Large
No, the plan does not state the level of service	8%	0%	9%
No, but we are planning to add the level of service	23%	50%	9%
Yes, the plan states the level of service according to regulatory requirement	46%	17%	36%
Yes, the plan states the level of service according to regulatory and technical requirements	8%	33%	36%
Does not apply	0%	0%	0%
I am not sure	15%	0%	9%

*N_{Small} = 13

Question 16: What aspects of climate change are considered by your organization in Asset Management Planning?

Question 16*	Small**	Medium	Large
Climate change was not considered in asset management planning	38%	33%	45%
Climate change is considered in our policy, however it is not clear how to put that into action	23%	17%	9%
Anticipated costs	0%	17%	9%
Mitigation and adaptation approaches	0%	33%	18%
Risk and disaster planning	15%	33%	18%
Does not apply	8%	17%	0%
I am not sure	15%	0%	27%

* Mark all that apply question type

**N_{Small} = 13

Question 17: Does your organization have a process to monitor the implementation of your Asset Management Plan?

Question 17	Small	Medium	Large
No	7%	0%	18%
No, but we are planning to establish a process to monitor plan implementation	50%	50%	36%
Yes, our organization monitors the plan implementation through an established process	14%	17%	18%
Yes, plan implementation is overseen by the organization and the council, through an established process	7%	17%	27%
Does not apply	0%	17%	0%
I am not sure	21%	0%	0%

Question 18: Does your organization have defined asset management objectives?

Question 18	Small	Medium	Large
No	21%	50%	18%
Yes, but asset management objectives are not well documented or communicated	43%	17%	9%
Yes, asset management objectives are well documented, communicated and consistent with the organization's objectives	14%	33%	18%
Yes, asset management objectives are well documented, communicated, and are consistent with the organization's objectives and additional requirements (technical, financial, regulatory, etc.)	14%	0%	36%
I am not sure	7%	0%	18%

Question 19: Does your organization have an Asset Management Policy?

Question 19	Small	Medium	Large
No	29%	33%	27%
Yes, but it is not well communicated within the organization	14%	50%	27%
Yes, and it is well communicated within the organization	29%	0%	18%
Yes, it is well communicated within the organization and provides a framework for asset management objectives	14%	0%	18%
I am not sure	14%	17%	9%

Question 20: Did your organization define the necessary actions to achieve its asset management objectives?

Question 20	Small	Medium*	Large
No	29%	20%	27%
Yes, but it is not well communicated within the organization	22%	60%	0%
Yes, and it is well communicated within the organization	21%	0%	9%
Yes, it is well communicated within the organization and provides a framework for asset management objectives	7%	20%	45%
I am not sure	21%	0%	18%

*$N_{Medium} = 5$

Question 21: Has your organization established an Asset Management System?

Question 21	Small	Medium	Large
No	21%	33%	18%
No, but we are planning to establish an Asset Management System	29%	67%	18%
Yes, we have set up the elements and processes required to an Asset Management System	29%	0%	27%
Yes, we have established an Asset Management System and are measuring and monitoring its progress over time	0%	0%	18%
I am not sure	21%	0%	18%

Question 22: Does your organization have clearly defined roles and responsibilities regarding leadership for implementation, operation, monitoring and improvement of asset management?

Question 22	Small	Medium	Large
No	14%	50%	18%
Yes, there are people responsible for asset management, but roles and responsibilities are not defined	29%	33%	9%
Yes, there is an accountable asset management team, but not all roles and responsibilities are defined	43%	17%	45%
Yes, there is an asset management team and their roles and responsibilities are clearly defined	7%	0%	27%
I am not sure	7%	0%	0%

Question 23: Has your organization established an asset management team with members from different departments?

Question 23	Small	Medium	Large
No asset management human resources were appointed so far	14%	17%	18%
Not yet, but the organization has appointed human resources to define and introduce an appropriate asset management framework	14%	0%	9%
The organization has established an asset management team, but it does not comprise human resources from different departments	14%	50%	9%
Yes, an asset management team with human resources from different departments is established	43%	33%	64%
I am not sure	14%	0%	0%

Question 24: Does your organization have council's support and commitment concerning asset management practices?

Question 24	Small	Medium	Large
No	0%	0%	9%
Yes, but council is not aware of asset management practices requirements	29%	33%	0%
Yes, council demonstrates buy-in and support for asset management	57%	33%	64%
Yes, council champions asset management as a core business function	0%	17%	0%
I am not sure	14%	17%	27%

Question 25: Did your organization allocate sufficient financial resources last year to develop the Asset Management Planned actions?

Question 25	Small	Medium	Large
No, asset management financial resources were not approved by council	0%	0%	0%
No, the allocated financial resources were not sufficient to develop the planned actions	14%	50%	9%
Yes, but the planned actions only comprised priority improvements to the asset management system	29%	17%	27%
Yes, there were sufficient financial resources to support the asset management planned actions	29%	33%	27%
I am not sure	29%	0%	36%

Question 26: Does your organization have asset data inventory?

Question 26	Small	Medium	Large
No, the organization works with limited asset data information	0%	0%	0%
Yes, the organization works with basic asset data information	29%	67%	45%
Yes, the organization works with adequate asset data information	43%	17%	36%
Yes, the organization works with comprehensive asset data information	14%	17%	18%
I am not sure	14%	0%	0%

Question 27: What is the confidence level in your organization regarding asset data inventory?

Question 27 - Water pipelines	Small	Medium	Large
Low	21%	0%	0%
Medium	14%	33%	36%
High	7%	50%	9%
Very High	21%	17%	45%
N/A	36%	0%	9%

Question 27 - Water treatment facilities	Small	Medium	Large
Low	14%	17%	27%
Medium	14%	50%	27%
High	43%	0%	27%
Very High	21%	33%	18%
N/A	7%	0%	0%

Question 27 - Wastewater pipelines	Small	Medium	Large
Low	21%	0%	9%
Medium	36%	50%	9%
High	36%	17%	36%
Very High	0%	33%	36%
N/A	7%	0%	9%

Question 27 - Wastewater treatment facilities	Small	Medium	Large
Low	14%	17%	18%
Medium	29%	33%	27%
High	43%	33%	36%
Very High	14%	17%	18%
N/A	0%	0%	0%

Question 28: What tools are used by your organization to manage assets and data?

Question 28*	All respondents
GIS	84%
Excel	68%
Cityworks	23%
Microsoft Access	16%
Infor Hansen	13%
Riva/PowerPlan	10%
I am not sure	10%
IBM Maximo	6%
Oracle Enterprise Asset Management	3%
SQL	3%
WorkTech (CMMS)	3%
Cartegraph	3%
InforEAM	3%
Internally built system	3%
InfraModex	0%

* Mark all that apply question type

Question 29: What is the main benefit your organization can derive from the current asset condition assessment practices?

Question 29	Small	Medium	Large
None, the organization has not established a process for condition assessment	14%	17%	0%
Improved operation services	0%	17%	18%
Inventory and criticality update	14%	0%	18%
Asset investment prioritization and improved decision-making	64%	67%	64%
I am not sure	7%	0%	0%

Question 30: Does your organization perform asset data analysis?

Question 30	Small*	Medium	Large
No, the organization works with limited asset data information and analysis, mostly used for operation and maintenance	31%	50%	9%
Yes, data analysis helps to determine asset condition and prioritization	54%	50%	64%
Yes, data analysis helps to determine current levels of service	0%	0%	0%
Yes, data analysis combines different data inputs to determine proposed levels of service	0%	0%	27%
I am not sure	15%	0%	0%

*$N_{Small} = 13$

Question 31: How is financial data used in your organization?

Question 31*	Small	Medium	Large
For yearly PSAB-3150 reporting requirements	50%	50%	73%
To set capital and operational expenditures	57%	67%	73%
To determine costs to maintain current levels of service	43%	33%	64%
To identify future needs and funding gaps	36%	33%	64%
I am not sure	14%	0%	9%

* Mark all that apply question type

Question 32: What is the main asset management source of information for planning and decision-making in your organization?

Question 32	Small	Medium	Large
There is no tool or source of information in place to manage assets	21%	17%	0%
GIS or other software that aggregates data	43%	67%	45%
Asset management plan	36%	17%	36%
Asset management plan aligned with the asset investment plan	0%	0%	9%
I am not sure	0%	0%	9%

Question 33: Has your organization established a process to address the new 588/17 Ontario Regulation?

Question 33	Small	Medium	Large
No, the organization needs help to understand the regulation's implications	7%	17%	0%
No, but the organization is starting to connect the asset management plan with municipality's budget	36%	17%	27%
Yes, the process for considering asset management plan in the municipality's budget is already in place	36%	50%	64%
I am not sure	21%	17%	9%

Question 34: How does your organization prioritize asset management investment decisions?

Question 34	Small	Medium	Large
Priority evaluation is based on experience, council and management input, and available information	43%	0%	18%
Prioritization usually addresses short-term needs and teams set priorities independently of each other	14%	83%	18%
Prioritization follows asset investment plans and are based on organizational objectives	21%	17%	9%
Prioritization follows asset investment plans and balance the current levels of service with longer-term goals and risks	14%	0%	45%
I am not sure	7%	0%	9%

Question 35: Does your organization have a process in place to identify possible future funding gaps?

Question 35	Small	Medium	Large
None, budgeting and capital investments are based on current needs.	29%	33%	9%
Yes, financial planning for capital investment is based on population growth.	0%	0%	9%
Yes, short-term (less than 5 years) financial planning for capital and operational expenditures is based on current levels of service	36%	33%	27%
Yes, long-term (more than 10 years) financial planning associated with asset lifecycle and levels of service	29%	17%	36%
I am not sure	7%	17%	18%

Question 36: Has a funding gap been identified for any of the following assets?

Question 36 - Water	Small	Medium	Large
No gap	7%	17%	9%
>0% - ≤20%	21%	33%	18%
>20% - ≤40%	21%	17%	9%
>40%	7%	0%	18%
Not sure	36%	33%	36%
N/A	7%	0%	9%

Question 36 - Wastewater	Small	Medium	Large
No gap	7%	17%	18%
>0% - ≤20%	29%	0%	18%
>20% - ≤40%	14%	33%	18%
>40%	7%	17%	9%
Not sure	36%	33%	27%
N/A	7%	0%	9%

Question 37: If a funding gap has been identified, how does the organization plan to cover it?

Question 37	Small	Medium	Large
Using government grants and funding	14%	17%	10%
By increasing the user fee	57%	17%	40%
Using revenue from other assets	0%	0%	10%
Does not apply	7%	17%	10%
I am not sure	21%	50%	30%

Question 38: Is your organization planning on increasing your water or wastewater user fees for the next 10 years?

Question 38	Small	Medium	Large
No	7%	17%	0%
Yes, according to the inflation rate	14%	17%	0%
Yes, from >0% to ≤20%	57%	50%	45%
Yes, from >20% to ≤50%	7%	0%	9%
Yes, >50%	0%	0%	9%
I am not sure	14%	17%	36%

Question 39: Does your organization encourage employees' asset management development?

Question 39	Small*	Medium	Large
No, asset management development approach is informal and largely driven by the initiative of team members	31%	50%	9%
Yes, but asset management development requirements are based on short-term needs (e.g. regulatory requirements)	31%	33%	18%
Yes, the organization promotes basic asset management awareness training to all employees	15%	17%	18%
Yes, the organization selects and trains internal experts to support the development of organizational capacity	15%	0%	55%
I am not sure	8%	0%	0%

*N_{Small} = 13

Question 40: Did your organization provide asset management training, guidance/mentoring or competence evaluation?

Question 40	Small*	Medium	Large
No, it had a "hit the ground running" approach	33%	67%	45%
Yes, it provided guidance through in-house asset management meetings/workshops	33%	0%	9%
Yes, it provided training by hiring specialized third parties or sending human resources to external training sessions	17%	33%	18%
Yes, it evaluated the competences needed and provided training and guidance based on them	0%	0%	9%
I am not sure	17%	0%	18%

*$N_{Small} = 12$

Question 41: Does your organization encourage internal asset management knowledge sharing?

Question 41	Small*	Medium	Large
No, asset management knowledge and information are concentrated in key people	15%	33%	18%
Yes, the organization is mitigating the risk of losing information through improved record keeping	23%	50%	36%
Yes, the organization is structuring asset management knowledge sharing resources	31%	17%	9%
Yes, asset management knowledge and information are freely shared throughout the organization	8%	0%	36%
I am not sure	23%	0%	0%

*$N_{Small} = 13$

Question 42: Does your organization participate in asset management events?

Question 42	Small*	Medium	Large
No, the organization does not attend asset management events	15%	17%	0%
Yes, the organization attends at least one event every year	38%	50%	36%
Yes, the organization attends at least one event per year and constantly searches for knowledge sharing opportunities	8%	17%	18%
Yes, the organization actively participates in asset management events and shares its experience with peers	23%	0%	27%
I am not sure	15%	17%	18%

*$N_{Small} = 13$